

Utah Aquatic Invasive Species Management Plan

(draft)



Prepared in coordination with
Utah Aquatic Invasive Species Task Force

by

Utah Division of Wildlife Resources

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The Utah Aquatic Invasive Species Management Plan was developed by the Utah Aquatic Invasive Species Task Force. The task force is comprised of tribal, federal, state, and local government natural resource managers; water user interests; and organized fishing groups who have either interest or authority for natural resource management actions. The task force and many individual members of the public provided direction and comment relative to the plan.

A special thanks is justly afforded to the following individuals (grouped with no logical order by agency), who are all members of the Utah Aquatic Invasive Species Task Force. Each member was generous in supporting development of the plan. All on the Task Force gave selflessly to achieve an improved situation for aquatic invasive species management in Utah.

Utah Division of Wildlife Resources:	Larry Dalton (chair) Walt Donaldson Evan Freeman Jenny Polloczek	Natalie Muth Dan Keller Crystal Stock
Utah Anglers Association:	Brock Richardson	
Utah Division of Water Resources:	Mike Suflita	
Utah State Parks & Recreation:	Bruce Hamilton	Dave Harris
Utah Department of Agriculture and Food:		Kent Hauck
U.S. Fish & Wildlife Service:	Bettina Proctor Chris Cline	Marianne Crawford
National Park Service:	Mark Anderson	Melissa Trammell
U.S. Forest Service:	Cynthia Tait	
Bureau of Land Management:	Justin Jimenez	
Central Utah Water Conservancy District:		Terry Hickman
Washington County Water Conservancy District:		Cory Cram Michelle Gregory
Bureau of Reclamation:	Russ Findlay	Amy Cutler
Utah Reclamation Mitigation Conservation Commission:		Maureen Wilson
Ute Tribe:	Jay Groves	

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Utah Wildlife Board

(August 28, 2008)

Recommended Action: Approve Utah Aquatic Invasive Species Management Plan

UTAH AQUATIC INVASIVE SPECIES MANAGEMENT PLAN

Prepared by the Utah Aquatic Invasive Species Task Force

Larry B. Dalton, Chair

Aquatic Invasive Species Coordinator

Executive Summary

(Review the entire plan: www.wildlife.utah.gov/invasivespecies/aisplan)

Utah, unfortunately, has become home to several species of Aquatic Invasive Species (AIS) over the years. Some AIS that exist in other areas of the nation and world have not yet made their way to Utah, but we fear they could. Prior to 2007 the Utah Division of Wildlife Resource only committed a small part of one staff person's time to the problem, although biologists statewide occasionally directed their efforts toward specific local AIS problems. Universities, tribal, federal, state and local government agencies, including private interests and organized sportsman groups, also on occasion directed some effort toward the AIS problem. The advancing threat from *Dreissena* mussels, based on the quagga mussel finding in Lake Mead, Nevada during January 2007, spurred the state of Utah to action. It was the "straw that broke the camel's back." Threats and impacts from the multitude of AIS already in the state, not to mention those on their way, became fully recognized as needing more attention.

Utah Division of Wildlife Resources in concert with other partners within the Utah Department of Natural Resources, launched an aggressive campaign in 2007 to:

1. Assess threats from *Dreissena* mussels.
2. Advise the public, particularly decision makers, of the ecologic and economic impacts from *Dreissena* mussels.
3. Develop needed policy to advise divisions within the Utah Department of Natural Resources and other departments within Utah state government about *Dreissena* mussels and how Utah would react.
NOTE: NR-07-D-11—Policy to Prevent Invasion of Zebra Mussel Into Utah Waters assigned Utah Division of Wildlife Resources as lead agency within Utah to carry out the program.
4. Initiate an emergency "Quagga Mussel Education and Implementation Plan."

5. Secure stable funding to conduct a more robust attack against AIS in general, with *Dreissena* species being a primary focus.
NOTE: The 2008 Utah Legislature appropriated \$2.5 million general funds, of which \$1.4 million is ongoing, to allow Utah Division of Wildlife Resources to conduct an AIS program.
6. Develop new laws as needed.
NOTE: The 2008 Utah Legislature unanimously passed the Utah Aquatic Invasive Species Interdiction Act. Thus, new rule R657-60 Possession of Aquatic Invasive Species, allowing enhanced AIS management and enforcement, provides authority to make stops of trailered watercraft at boat launch sites, administrative check sites, and Utah ports of entry, including a mandate for self-certification pre-launch by watercraft operators declaring their boats and equipment to be mussel free. It also allows the closing of water bodies that become infested with *Dreissena* mussels until an acceptable plan for containment and control is developed.
7. Develop and implement a comprehensive Utah Aquatic Invasive Species Management Plan.
NOTE: The Utah Aquatic Invasive Species Task Force, representing a multitude of tribal, federal, state, and local government agencies; private water use businesses; and organized anglers; was formed to prepare and guide implementation of this “Utah Aquatic Invasive Species Management Plan.” The plan was subjected to public review via Utah Division of Wildlife Resources’ five statewide Regional Advisor Councils and approved by Utah’s Wildlife Board and the governor, which led to ultimate approval by the national Aquatic Nuisance Species Task Force.

The main thrust of Utah’s Aquatic Invasive Species Management Plan is to deal with *Dreissena* mussels, although many activities are ongoing with other AIS. New Zealand Mud Snails have been found in Utah’s Loa Hatchery, and they have been found at Utah’s Midway Hatchery on the property, but not in the hatchery yet. Actions are ongoing in Utah’s hatchery system to deal with the mud snail problem. Individual hatchery Hazard Analysis Critical Control Point plans are in place, and the Utah Division of Wildlife Resources New Zealand Mud Snail (*Potamopyrgus antipodarum*) Management Plan for Loa Hatchery has been implemented.

Utah Division of Wildlife Resources’ AIS biologists and others have found New Zealand mud snails in river and stream segments previously not known as infested. Verification of New Zealand mud snail identifications has been done by Utah’s Natural Heritage Program.

Others in the aquatic section aided by Utah Aquatic Invasive Species Task Force partners are moving forward to spray treat Eurasian Milfoil in Mantua Reservoir and Fish Lake. Re-treatments may occur as needed.

Additionally, spray treatment followed by burning of common reed (*Phragmites* spp.) has been ongoing for several years and will continue through the efforts of Utah Division of

Wildlife Resources' waterfowl personnel throughout Utah's wetlands along the east side of the Great Salt Lake and other places. Likewise, tamarisk treatment statewide has been ongoing for years. Utah Aquatic Invasive Species Task Force partners have been participants to varying degrees for treatment of both species.

A full time AIS coordinator is now assigned to Utah Division of Wildlife Resources' aquatic section to lead a statewide program, and an AIS outreach specialist is assigned to assist with outreach needs. Also, five full time AIS biologists have been placed in the aquatic section--one in each of Utah Division of Wildlife Resources' five regions. Also, 35 wildlife technicians have been assigned as seasonal employees in the aquatic section to perform as watercraft inspectors; they were placed at priority waters statewide. Most technicians were provided with a trailer-mounted decontamination unit capable of spraying high pressure, scalding (140 degree Fahrenheit) water, which will kill all the AIS known either within or threatening Utah. Five conservation officers have been placed to assist, as needed, with AIS law enforcement needs.

Some of the Utah Aquatic Invasive Species Task Force partners have been able to secure funding to assist in this effort, too.

In an attempt to better perform early detection of *Dreissena* mussels, Utah Division of Wildlife Resources' Fishery Experiment Station is coordinating with Utah State University's Fish and Wildlife Department on possible ongoing research comparing various early detection methodologies. Early detection could allow attack on an invading population of *Dreissena* mussels, possibly controlling or eradicating them. Knowledge gained from this research may lead to protocols for early detection of other AIS, too, allowing successful eradication or early control.

The *Dreissena* mussel campaign, beyond water craft interdictions by AIS biologists, technicians and others, including Utah Division of Wildlife Resources' conservation officers, Utah State Parks and Recreation's rangers, other Utah peace officers and Utah Department of Transportation's port of entry agents, is mostly an outreach effort. That effort operates under the U.S. Fish and Wildlife Service's national "Help Stop Aquatic Hitchhikers" program logo and slogan. This allows coordination among all states in the nation in order to fight aquatic invasive species. Presentations in Utah and at national meetings about AIS, particularly the quagga and zebra mussel threat, have been made to many interested publics (e.g., tribal, federal, state, and local governments and sportsman organizations).

Significant actions for outreach implementation as supported by available budget will continue as follows:

1. Utah Division of Wildlife Resources aided by our many partners, including the Utah Aquatic Invasive Species Task Force, is placing the 100th Meridian Initiative's "Zap the Zebra" brochure (250,000 units per year) statewide at locations where boaters and anglers will encounter it. During 2007 the effort included direct mail by Utah State Parks & Recreation of the brochure to 65,000

registered boaters in Utah.

NOTE: Utah Division of Wildlife Resources is negotiating with the Utah Division of Motor Vehicles to incorporate an AIS message in their annual vehicle registration packets to boaters.

2. Utah State Parks & Recreation is direct mailing a notice to all fresh water boat dock users (500 units) in the state park system, detailing the quagga and zebra mussel threat, including need for decontamination of boats and equipment.
3. Utah Division of Wildlife Resources is placing table-top displays (5,000 units per year), urging the public to "Help Stop Invasive Mussels" and to properly decontaminate their boats and equipment, across Utah at restaurants, boat dealer counters and other places where boaters and anglers would encounter the message.
4. Numerous highway billboards are being placed statewide, urging boaters to "CLEAN," "DRAIN," and "DRY" their boats to aid in the fight against the spread of AIS. Billboard presentation equates to 168 months of advertising display.
5. Utah Division of Wildlife Resources is placing signs (1,500 units per year as full color foam core 11" x 17") and identical posters (4,000 units per year as full color 11" x 17") across Utah in areas frequented by boaters and anglers.
6. Utah Division of Wildlife Resources is placing entry signs (150 units per year as full color metal 33" x 54"), similar to the aforementioned poster, that demand self-certification as "mussel free" by boaters prior to launch at all significant water bodies across Utah.
7. The corner stone of the outreach effort, which is directly linked to the watercraft inspections, is a self-certification program for boaters to document that their watercraft have either not been contaminated with *Dreissena* mussels, or that their boats have been properly decontaminated. Every boater contacted will be asked to certify pre-launch that they have done their part to "Help Stop Aquatic Hitchhikers." Boaters will be presented with a self-certification form and asked to sign and display it on the dashboard of their vehicle. Boaters who arrive at times when no agency personnel are present, will be instructed via the aforementioned metal entry signs to secure a self-certification form and to fill it out, displaying it on their dashboard. Containers making the self-certification form available 24/7 will be mounted with the aforementioned metal entry signs. Decontamination units are located at or nearby to most boating waters in Utah. Unfortunately, sufficient funds are not available to staff boat launch sites on a 24/7 basis. Possibly, launches during after hour times could be closed for incoming boaters by fencing off the boat ramp and installing one-way tire deflating devices. Boaters could still safely leave a site after hours, but those arriving could not launch until their boat is properly inspected by trained personnel.

NOTE: It is unlawful (R-657-60) for a boat to launch that needs decontamination.

8. The National Park Service at Lake Powell has been an outstanding cooperator, aiding Utah Division of Wildlife Resources and leading by example. They have conducted a similar *Dreissena* mussel campaign at Lake Powell as described above and began it several years ago.
9. The Utah Aquatic Invasive Species Management Plan includes a "rapid response plan." It will guide the Utah Aquatic Invasive Species Task Force and water body

managers in dealing with new arrivals of AIS or the spread of existing AIS.

Utah Aquatic Invasive Species Management Plan

Prepared by

Utah Aquatic Invasive Species Task Force

Larry B. Dalton, Chair, Aquatic Invasive Species Coordinator
Utah Division of Wildlife Resources

Approved by

James F. Karpowitz, Director, Utah Division of Wildlife Resources

Signature

Date

Paul Niemeyer, Chair, Utah Wildlife Board

Signature

Date

Gary Frazer, Co-Chair, Aquatic Nuisance Species Task Force
(Acting Assistant Director for Fisheries & Habitat Conservation,
U.S. Fish and Wildlife Service)

Signature

Date

Timothy Keeney, Co-Chair, Aquatic Nuisance Species Task Force
(Deputy Assistant Secretary for Oceans, U.S. Department of
Commerce/NOAA)

Signature

Date

Jon M. Huntsman, JR., Governor, State of Utah

Signature

Date

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Introduction

Aquatic Invasive Species That Threatens Utah

Aquatic invasive species (AIS) are not strangers to Utah. In fact numerous AIS species now inhabit Utah or threaten the state with immediate arrival. The list includes pathogens, fungi, algae, plants, mollusks, fish, amphibians and reptiles (Appendix A). Some have been present almost since the initial arrival of the pioneers in the mid 1800s, and the numbers of different species, their abundance, and their distribution seems to be on a constant march upward. AIS are defined as water-associated non-native plant and animal species that threaten the diversity or abundance of native species due to their uncontrollable population growth, causing ecological instability of infested waters, or economic damage to commercial, agricultural, aquacultural, or recreational activities dependent on such waters. The term AIS in many documents and laws is referenced as Aquatic Nuisance Species; for purposes of this plan both aquatic invasive species and aquatic nuisance species mean the same thing.

AIS are defined in part as non-native. However, not all non-native species are viewed as a nuisance, since many are not invasive. Some non-native species support human livelihoods or a preferred quality of life, although they can in some situations have adverse impacts on desired species (e.g. sport fish impacts on sensitive species).

Populations of AIS all over North America have expanded, spreading rapidly due to lack of natural controls, and their ability to adapt to a variety of habitats. AIS are known to cause significant ecological and socio-economic problems throughout the world. Just within North America, populations of AIS, such as *Dreissena* mussel species [quagga (*Dreissena bugensis*) and zebra (*Dreissena polymorpha*)], dark false mussel (*Mytilopsis leucophaeta*), New Zealand mud snail (*Potamopyrgus antipodarum*), Eurasian watermilfoil (*Myriophyllum spicatum*), and the parasites that cause whirling disease in *Salmonids*, are increasing in prevalence. These and other AIS species either exist or are threatening to arrive in North America, and many will eventually threaten Utah, too.

Why Manage Aquatic Invasive Species in Utah

AIS are simply bad for Utah's environment and economy for a multitude of reasons. AIS challenge our native species, out-competing them for food, displacing them from natural habitats or infecting them with disease. AIS obstruct flow in waterways, impacting municipal, industrial, and irrigation water supply delivery. AIS degrade ecosystems, reducing or threatening recreational or commercial fishing opportunities. And, AIS can cause wildlife and public health problems. These reasons are not all-inclusive, but alone they give cause for serious concern and need for aggressive management.

For Utah the concern about AIS increased dramatically in the early 1990s with the arrival of Whirling Disease. Then, the alarm truly rang loudly when quagga mussels were discovered in Lake Mead, Nevada during January 2007. Soon thereafter the Utah Department of Natural Resources began an assessment of threats to Utah, and put policy

NR-07-D-11 (Appendix B) into effect to prevent invasion of *Dreissena* mussels into Utah's waters. The policy assigned Utah Division of Wildlife Resources as lead agency within Utah to carryout such a program. Concurrently, Utah Division of Wildlife Resources implemented a Quagga Mussel Education and Implementation Plan (Appendix C) for purposes of informing the public about threats and impacts from a *Dreissena* mussel infestation. A specific target for outreach was decision makers who had authority to make funds available for plan implementation. The plan would also facilitate interdiction of watercraft transporting AIS, leading to decontamination of infested boats and equipment.

These latest efforts were not Utah's first steps at AIS management, but they certainly represented a rapidly changing attitude that AIS, particularly the *Dreissena* mussel threat, would require a focused, well funded effort to achieve satisfactory management results. Prior to 2007 the Utah Division of Wildlife Resource only committed a small part of one staff person's time to the AIS problem, although biologists statewide occasionally directed their efforts toward specific local issues. Utah Division of Wildlife Resources' Fish Experiment Station in Logan, Utah has for decades provided strong, national leadership in the fight against aquatic pathogens and innovations in fish culture. Universities, tribal, federal, state and local government agencies, including private interests and organized sportsman groups in Utah also have on occasion directed some effort toward different AIS problems.

Eurasian watermilfoil during the early to mid 1990s became established in northern Utah's Mantua Reservoir and southern Utah's Fish Lake; its spreading due primarily to recreational boats. New Zealand mud snail populations also seemed to proliferate all over the state during the mid 2000s, possibly moving through irrigation systems and on the soles of angler's felt-soled waders. However, the growing threat from a discovered, but well established quagga mussel population in the lower Colorado River drainage spurred the state of Utah to an accelerated level of action. It was the "straw that broke the camel's back." Again, the AIS problem increased in late 2007 when a population of New Zealand mud snail was found in southern Utah's Loa State Fish Hatchery, causing it to be quarantined. A New Zealand mud snail management plan for the hatchery was written, implemented, and decontamination is underway (Appendix D). New Zealand mud snail have since been discovered in early 2008 on the grounds of central Utah's Midway State Hatchery; fortunately mud snails are not yet inside the hatchery facilities. (**Note:** Individual hatchery Hazard Analysis Critical Control Point plans are in place for every state hatchery.) Thus, threats and impacts from the multitude of AIS already in the state, not to mention those on their way, are fully recognized as needing more attention.

What's at Stake in Utah--Economic and Ecologic Impacts

Degradation by AIS of Utah's aquatic wildlife resources (species, habitats and water-based recreation areas) may well imperil not only those resources, but the economy of local communities in the state. Certainly, the compromising of sensitive species in Utah by AIS could lead to additional listings under the Endangered Species Act, which represents a failing for individual species' population health and welfare. Such action has

the potential to hamper economic development in local communities, since compliance with conservation actions driven by the Endangered Species Act can be mandated. Sometimes compliance is costly, nonetheless important and needed, but it is not uncommon for development plans to be delayed or altered in order to meet Endangered Species Act compliance.

Additionally, anglers who fished in Utah since 1995, including anglers across the nation over the last two decades, have shown a propensity to redirect their recreational endeavors to something other than fishing when inconvenienced by difficult regulations, poor success, poor quality fish, or an unpleasant fishing experience (Dalton 2003 and 2006; U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 1991, 1996, 2001 and 2006). *Dreissena* mussels and other AIS will lead to all of those situations. Once anglers quit the sport, it is very difficult to get them to return, which is evidenced by a slight decrease in fishing license sales in Utah. Aquatic conservation by Utah Division of Wildlife Resources is mostly funded by angler's purchase of fishing licenses and angler associated federal aid to the state. Expenditure by the 375,311 anglers who fished in Utah during 2006 for goods and services that supported their angling efforts exceeded \$708 million, supporting more than 7,000 jobs in Utah's communities (Southwick Associates, Inc. 2007).

Boating in Utah during 2006 was less than in 1999. The Institute for Outdoor Recreation and Tourism at Utah State University in a 2007 report for Utah State Parks and Recreation, showed 76,000 registered boats in Utah during 2006. Those numbers are a surprising increase of 800 over the previous year. The increase is notable in view of a long-term decline, since the acreage of water available for boating remains relatively constant in Utah. AIS impacts to boaters may further reduce their participation at lakes and reservoirs that become infested, since the boater's favorite lakes are those with quality fishing. For example, *Dreissena* mussels can plug the water circulation system in boats, causing engines to overheat and become seriously damaged. Eurasian watermilfoil restricts boat use, particularly in the near shore zones. And, more mandatory decontamination protocols are being imposed, so boaters don't inadvertently move AIS while transporting their watercraft between recreation areas. It is estimated that lost revenue in Utah's communities due to decreases in boating could be substantial. Utah boaters annually expend at least \$276 million for goods and services supporting their sport, which supports more than 4,300 jobs statewide (Harris, 2008).

The two decade long history of *Dreissena* mussels fouling water conveyance systems just in North America is well documented (O'Neill, 1996). Expenditures for maintenance have been significant, with the infested areas spending nearly \$100 million per year. *Dreissena*'s spread across Europe outside their native range has caused similar economic challenges (O'Neill, 1996). No doubt, impacts from *Dreissena* and other AIS represent real threats to Utah's economy and could alter all Utahans' quality of life. Utah Division of Water Resources has estimated based upon maintenance expenditures east of the 100th Meridian, that cost to Utah on an annual basis due to infestation by just *Dreissena* could exceed \$15 million (personal communication Mike Suflita, Utah Division of Water Resources). That estimate did not include maintenance cost to Utah's 1,200 miles of

major pipelines or the vast system of secondary pipelines and irrigation systems within the state, nor Utah's 4,500 miles of canal.

Laws That Govern AIS Management

National AIS Laws

Due to the multitude of environmental and socio-economic impacts posed by AIS, many governmental and non-governmental entities have recognized need for regulation. In 1990 the Nonindigenous Aquatic Nuisance Prevention and Control Act was passed by Congress and enacted to address AIS problems in the United States. This legislation provided federal cost-share support for implementation of state AIS plans. The 1990 act established the national Aquatic Nuisance Species Task Force, which is co-chaired by the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration. Although programs created by the Nonindigenous Aquatic Nuisance Prevention and Control Act initially were aimed at problems in the Great Lakes region, its reauthorization in 1996 as the National Invasive Species Act established a national goal of preventing new aquatic nuisance species introductions and limiting the dispersal of existing AIS in all of the states. The 1996 act directed the U.S. Coast Guard to establish regulations and guidelines to control the introductions of AIS via ballast water discharge into waters of the United States. It also directed the U.S. Army Corps of Engineers to develop a program for research and technology to control *Dreissena* mussels and to make available information on control methods. The National Invasive Species Act also specified that state AIS plans identify feasible, cost-effective management practices and measures that can be implemented by states to prevent and control AIS infestations in a manner that is environmentally sound. And, in 1999 the Executive Order 13112 on Invasive Species established the national Invasive Species Council (Secretaries of State, Treasury, Defense, Interior, Agriculture, Commerce, Transportation, and the Administrator of the Environmental Protection Agency) to oversee activities of existing federal organizations that address invasive species issues, in order to increase public awareness, coordinate federal and state activities, provide technical assistance and research, and prevent importation of nuisance species. Then in 2005, the National Aquatic Invasive Species Act was authorized, which reauthorized and amended the prior Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, and the National Invasive Species Act of 1996.

The national Aquatic Nuisance Species Task Force formed six Regional Panels across the nation to deal with AIS issues as a result of the aforementioned legislation and executive order. Each panel is chaired by the U.S. Fish and Wildlife Service. Additionally, the 100th Meridian Initiative was formed as an effort to keep *Dreissena* mussels east of the 100th Meridian. The initiative resulted in five River Basin Teams. Utah is part of the Western Regional Panel and the 100th Meridian's Colorado River Basin Team.

Additionally, the U.S. Fish and Wildlife Service administers the Endangered Species Act as part of its authority to affect AIS impacts that could extend to a listed species or listed critical habitat. They also administer the Lacey Act and the Injurious Species Act.

Both acts regulate importation and interstate transportation of fish and wildlife, while the latter act further regulates specified species deemed to be injurious to the United States.

The Bureau of Reclamation administers a small, but significant acreage in Utah as “withdrawals” from other federal land management agencies for purposes of managing water development projects. They exercise AIS management on those properties. Many other federal acts in-part focus upon AIS management. For example, acts of significance follow:

The Clean Water Act, administered by the Environmental Protection Agency, strives to eliminate introduction of toxic substances into waters of the United States to ensure that surface waters are suitable for human sports and recreation. Additionally the Clean Water Act regulates discharge of dredge and fill materials into wetlands; enforcement as it relates to wetlands is coordinate by the U.S. Army Corps of Engineers.

The Plant Protection Act, administered by U.S. Department of Agriculture Animal and Plant Health Inspection Service, prohibits introduction and dissemination of plant pests and noxious weeds.

The National Forest Management Act, the Federal Land Policy Management Act, and the National Park Act, administered by the U.S. Forest Service, Bureau of Land Management, and National Park Service, respectively, regulate native species, non-indigenous species introductions and habitat health on most of the federal land in Utah.

The Central Utah Project Completion Act, administered by the Utah Reclamation, Mitigation Conservation Commission, besides providing for the completion of the Central Utah Project and maintenance of its facilities, affords enormous mitigation opportunity and perpetual funding for either unrecognized impacts or a continuation of mitigations for wildlife impacts.

The Farm Bill, administered by Natural Resources Conservation Service, working in close partnership with Utah’s Association of Conservation Districts, strives to improve private agricultural lands for wildlife habitat and agricultural purposes. In part, they target management of AIS as they affect production of crops or product from private land.

Note: the Natural Resources Conservation Service manages the National Invasive Species Information Center (www.invasivespeciesinfo.gov).

Several Native American tribes--Navajo, Northern Ute, White Mountain Ute, Northern Goshute, Southern Goshute, Paiute, Shoshone--exist or have hunting and fishing rights within Utah. The Ute Tribe and the Navajo Tribe each control significant areas (e.g. the Navajo Nation borders most of the southern border of Lake Powell and the Ute Nation includes several boating waters) with potential for infestation by AIS, particularly *Dreissena* mussels. The other tribes have limited resources at risk where AIS could

become an issue. The tribes under treaty with the United States maintain absolute authority for resource management on their lands, but are advised by the U.S. Fish and Wildlife Service concerning wildlife management issues.

Several international agreements also afford protection from AIS for the United States.

Utah Laws That Relate to AIS

Utah Code, section 23, establishes Utah Division of Wildlife Resources as the authority for wildlife management in the state, but the authority only extends to species defined as “protected wildlife.” Thus, neither Utah Code nor associated rule provides authority for the management of plant species by Utah Division of Wildlife Resources, including those plant species recognized as AIS. Chapters 13 through 27 of section 23 in the Utah Code and an array of associated Utah Rules address wildlife management issues regarding protection, management, take, possession, importation and exportation of protected wildlife, which includes quagga and zebra mussel considerations, making them prohibited species. Chapter 27 is the codification of the Aquatic Invasive Species Act (Appendix E1), and authority for enforcement of the Act is facilitated by Rule R657-60, Aquatic Invasive Species Interdiction (Appendix E2). The Act and Rule only consider *Dreissena* species, providing greater authority for Utah to interdict watercraft and equipment or inspect waters infested with *Dreissena* mussels. Utah Division of Wildlife Resources, Utah Peace Officers (includes Utah State Park and Recreation rangers), and Utah Port of Entry Agents now have authority to inspect equipment to determine contamination by *Dreissena* mussels, particularly equipment that has been at any infested waters within the last 30 days. The authority extends to compelling decontamination as necessary. Additionally the authority allows closure of infested water bodies until the operator has developed a satisfactory plan to control and eradicate *Dreissena* mussels.

Utah Code (??-??-??) provides the Utah Department of Agriculture and Food authority over noxious weeds (??-??-??), some of which are AIS. Management of AIS plant species in Utah results from interagency cooperation, exercising other agency’s or private land owner’s authority. Most AIS plant associated management activity in Utah involves cooperative arrangements between Utah Department of Agriculture and Food, Utah Division of Wildlife Resources and Utah Division of State Lands and Forestry, State Institutional Trust Lands Administration, Utah State Parks and Recreation, along with the aforementioned federal land management and conservation agencies.

Utah Code (??-??-??) demands that all vehicles importing aquatic animals into Utah or through Utah must have documentation (Livestock & Fish Movement Report). Imported aquatic animals and their documentation are subject to inspection either at Utah ports of entry or at Utah Department of Agriculture and Food offices; entry denial, fines, or other action may occur. Utah Department of Agriculture and Food works cooperatively on aquatic animal importation and transportation with Utah Division of Wildlife Resources and the Utah Department of Health under a memorandum of understanding. Utah Department of Agriculture and Food provides standards for importation of aquatic wildlife for aquaculture, control of depredating aquatic animals, enforcement of rules, prevention of disease, and spread of disease among and from imported aquatic animals,

and regulatory decisions for suspect disease endangerment in fish. They also through the Fish Health Program regulate entry permits for all national and international importations of aquatic animals for aquaculture purposes into Utah. Utah Division of Wildlife Resource and Utah Department of Agriculture and Food cooperative work to grant health approvals for imported aquatic animals. This oversight extends to federal, state and private aquaculture facilities. And, because live fish (and water) are imported, the fish health approval process is done for each aquaculture facility on an annual basis. The approval process includes review of current status of AIS at each facility, AIS proximity to each facility, and AIS proximity to export locations. The applicant is required to follow certain procedures to treat, test, or remove AIS from the fish and the water.

Importation of ornamental fish, including those deemed to be AIS, are not effectively regulated, but if the Utah Department of Agriculture and Food or the Utah Division of Wildlife Resources determines that an introduction of ornamental fish poses a disease risk for aquatic animals, then existing rules may be the vehicle to regulate the private ornamental fish industry to protect against AIS. The spring viremia of carp virus is now applied as needed to ornamental fish.

Additionally, certain “emergency prohibited” and “prohibited” pathogens fit the definition of AIS--viral hemorrhagic septicemia, whirling disease, Asian tapeworm (*Bothriocephalus acheilognathi*), and the trematode *Centrocestus formosanus*. Utah Department of Agriculture and Food requires treatment or testing of all proposed imports that could be host species or carriers or even susceptible hosts of these pathogens. (Note: The Asian tapeworm host list is attached as Appendix F.) In the unfortunate event of an aquaculture facility becoming infested by AIS, quarantine may be imposed where it is reasonably necessary to protect aquatic animals within the state. Release of any live or dead imported aquatic animal into public waters is illegal.

The **Utah Code (??-??-??)** establishes Water Conservancy Districts as political subdivisions of the State of Utah to develop water supplies for their service areas. They are primarily a wholesaler of water to other agencies (cities), and they own and operate a multitude of water storage, treatment and delivery facilities, some of which are major recreation reservoirs and State Parks. The Water Conservancy Districts have authority to protect and maintain their facilities in face of an AIS threat.

Other Efforts to Facilitate AIS Management

Utah Division of Wildlife Resources as a member of the Association of Fish and Wildlife Agencies and the Western Association of Fish and Wildlife Agencies is in constant contact with a multitude of international and national wildlife management agencies and other interested publics attempting to deal with AIS. These groups are regularly stimulated to become more aggressive by the national Aquatic Nuisance Species Task Force, who is proposing that the Western Governors Association meeting in 2008 include the topic of AIS in order to bring more focus on AIS issues from the top administrative office in the various states of the west. Previously in 1998 and 2005 the Western Governors Association passed resolutions 98-018 and 05-11 dealing with “Undesirable Aquatic and Terrestrial Species” and “Undesirable, Invasive Aquatic and Riparian Species,” respectively. Utah Department of Natural Resources already has strong support

from the Utah Governor's office and the Utah legislature. The Utah Department of Natural Resources has urged Utah's governor to stimulate other western governors to more fully and aggressively deal with AIS.

Additionally, Utah Division of Wildlife Resources has taken a lead role in the west for initiating AIS program with significant gubernatorial and legislative support for program budget. As a result, an array of western states has been in constant contact, seeking advice about "how did Utah do it." Utah Division of Wildlife Resources has shared process and outreach product with an array of western and other states. Regarding the states that surround Utah, Idaho already has an approved AIS plan; Colorado is in process of preparing a plan; New Mexico is showing progress toward an AIS plan; Nevada and Arizona, too have approved AIS plans. Unfortunately, Wyoming seems to not be doing much, although Wyoming shares Flaming Gorge Reservoir with Utah—the reservoir is at great risk for infestation by *Dreissena* mussels.

Utah's AIS Management Plan

Action Plans and Hazard Analysis Critical Control Point Plans for Utah

Already several action plans dealing with AIS exist within Utah (e.g. National Park Service's "Zebra Mussel Prevention at Glen Canyon National Recreation Area;" Utah Division of Wildlife Resources' "Action Plan for Containment of Quagga Mussel at Lake Powell," "Quagga Mussel Education and Implementation Plan," and "New Zealand Mudsail (*Potamopyrgus antipodarum*) Management Plan For Loa Hatchery"). The same is true for Hazard Analysis Critical Control Point plans that in-part address AIS in Utah (e.g. U.S. Fish and Wildlife Service's "Utah Field Office Hazard Analysis Critical Control Point Plan," "Ouray National Hatchery Hazard Analysis Critical Control Point Plan," "Jones Hole National Hatchery Hazard Analysis Critical Control Point Plan," and Utah Division of Wildlife Resources' 12 Utah State Fish Hatchery Hazard Analysis Critical Control Point plans—Fish Experiment Station, Loa, Midway, Kamas, Springville, Whiterocks, Mantua, Glenwood, Egan, Mammoth Creek, Wahweap, Fountain Green). Others action plans and Hazard Analysis Critical Control Point plans will likely result, providing greater focus for AIS management at specific locales in Utah.

Purpose of Utah's AIS Management Plan

In 2008 Utah Division of Wildlife Resources formed and chaired a Utah Aquatic Invasive Species Task Force for the purpose of developing and implementing this Utah Aquatic Invasive Species Management Plan. Members of the task force represent multiple tribal, federal, state, local and private conservation entities, and they are listed in the Acknowledgements section of this plan. Plan implementation is ongoing, and each entity of the task force shoulders varying degrees of responsibility for program conduct, which is determined by their statutory authority and budget strength during individual years.

The primary purpose for a Utah Aquatic Invasive Species (AIS) Management Plan is to develop and document a program and associated protocols to be implemented for AIS management within Utah. The Utah plan has been developed to be strategic in scope; it will serve as the foundational document to guide planning and conduct of work as it relates to AIS in Utah. And, at times it will serve as a supportive document for AIS grant applications. The plan will undoubtedly be the base from which other AIS action plans tier.

The Utah Division of Wildlife Resources has committed numerous full time equivalencies (25.21) to the Utah AIS program as follows:

- Statewide AIS Coordinator;
- Statewide AIS Outreach Specialist;
- 5 Regional AIS Biologists;
- 35 Wildlife Technicians (seasonal watercraft inspectors);
- 5 Conservation Officers to assist part-time with AIS enforcement issues.

Additionally, Utah Division of Wildlife Resources has secured \$2.5 million for AIS program work in FY2008 and FY2009, of which \$1.4 million is ongoing general funds.

Multiple outreach products--brochures, flyers, signs and billboards, 26 trailer mounted decontamination units, and routine operational costs for Utah Division of Wildlife Resources' staff are supported by the funds.

The U.S. Fish and Wildlife Service's Denver Colorado Regional Office maintains an Aquatic Nuisance Species Coordinator. The U.S. Forest Service's Intermountain Regional Office in Ogden Utah maintains an Aquatic Nuisance Species Coordinator, too. And, the Bureau of Reclamation's Regional Office in Salt Lake City Utah also maintains an intra-agency AIS task force. All three of these agencies serve on the Utah AIS Task Force. Each position is funded by its respective agency such that significant programmatic support is directed toward implementation of Utah's AIS Management Plan.

All of the other Utah AIS Task Force members have additional agency roles besides their assignment to the Utah AIS Task Force. They are individually committed to keep AIS in strong focus within their respective agencies, including the provision of funds and personnel, when possible, for in-the-field operations.

Goal of Utah's AIS Management Plan

The goal of the Utah AIS Management Plan is to improve the ability of natural resource management entities within Utah to prevent invasion of AIS into the state, and to contain AIS through accepted management practices to areas that are either already infested or become infested.

Objectives and Strategies of Utah's AIS Management Plan

Outreach Objective: The Utah AIS Management Plan will establish and increase outreach efforts directed at public education. The intent is so Utah's public, particularly the media, governmental agencies, outdoor-associated recreational organizations, boaters, and anglers will realize the threats and impacts from AIS, and become partners in AIS education, interdiction and decontamination, as well as management.

- **Media Strategy:** Coordinate Utah's media (national, regional, statewide and local newspapers, magazines, radio stations and television stations, including targeted programming—"Utah at Your Leisure" and "Roughin It Outdoors") to repeatedly tell the AIS story, by identifying opportunity for the media to market their publications and broadcasts, promoting the "Stop Aquatic Hitchhikers" slogan in combination with the decontamination protocols.
- **Public Education Strategy:** Educate the public, particularly Utah boaters, at a variety of venues (e.g. organized angler and boater meetings, International Sportsman Expo, Greenspan Boat Show, Garden Show, state and county fairs, launch sites and Utah's Ports of Entry) about AIS. The process will be to explain the AIS issue, and encourage the public to

spread the “word,” creating peer pressure for decontamination compliance. This strategy also includes presentations to natural resource management agencies within Utah and across the west about the AIS issue.

- Pursue cooperative opportunities to expand the education strategy to venues like the Living Aquarium and their educational van (they visit schools in the Wasatch Front area of Utah), Hogle Zoo and their docent education program (they visit schools statewide), the Utah Natural History Museum, all located in Salt Lake City, UT.
- Display AIS outreach product produced by Utah Division of Wildlife Resource stateside at boat dealers and marine repair shops, restaurants, local dive shops, and sporting good stores. Note: Cabela’s and Sportsman Warehouse are each willing and have facilities that can be used for public AIS presentations.
- Pursue opportunity to make AIS presentations at venues where water user groups gather (e.g. Utah Water Users Conference, river basin meetings, water rights managers meeting, etc.).
- **Next Generation Education Strategy:** Coordinate with Utah’s educators in concurrence with the state science coordinator to educate the next generation of boaters by developing formalized in-class-room tutorials for secondary level school teachers to present to their students. The educational content must correlate to Utah’s core curriculum.
- This strategy also includes web site development for AIS message delivery, and the sharing of educational material amongst the Utah AIS Task Force and other states.
- Coordinate with appropriate local university and college personnel to make AIS presentations to their students, either in classroom settings or as a visiting lecturer at organized symposiums.

Interdiction and Decontamination Objective: The Utah AIS Management Plan will facilitate increased interdictions of boats and equipment contaminated with AIS, requiring decontamination under authority of the Utah Aquatic Invasive Species Interdiction Act in order to control the spread of AIS.

- **Interdiction Strategy:** Utah Division of Wildlife Resources’ staff, including authorized volunteers, Utah Peace Officers, which includes Conservation Officers and state Park Rangers, and Utah Department of Transportation Port of Entry Agents, under authority of the Utah Aquatic Invasive Species Interdiction Act, and other properly trained natural resource management personnel, will interdict boats at launch ramps,

administrative check sites, and Utah's Ports of Entry to detect boats and equipment contaminated with AIS.

- **Decontamination Strategy:** Boat owners and operators will be contacted in-the-field or at a variety of other venues, including through media publications or broadcasts, one-on-one education or at group presentations, in order to tutor them about AIS. The boaters will be provided guidance about how to decontaminate their watercraft and equipment as per established protocols.
 - **Do-it-Yourself Decontamination:** Boat owners must clean and drain their boat and equipment as they leave a water body, then dry it for an appropriate amount of time between boating trips at home.
 - Clean mud, plants, animals or other debris from boat or equipment;
 - Drain the ballast tanks, bilge, livewells, and motor;
 - Dry boat and equipment for 7 days summer, 18 days spring or fall, or freeze the boat and equipment in winter for 3 days;

or

- **Professional Decontamination:** Utah Division of Wildlife Resources' staff, including authorized volunteers, Utah Peace Officers, which includes Conservation Officers and state Park Rangers, and Utah Department of Transportation Port of Entry Agents, under authority of the Utah Aquatic Invasive Species Interdiction Act, and other properly trained persons, will decontaminate boats and equipment infested with AIS as per established protocols. This effort due to capitalistic opportunity is intended to induce proper decontaminations by private vendors.
 - Wash the trailer and boat inside and out, including flush ballast tanks, bilge, livewells and motor with high pressure, 140 degree scalding water.

Management Objective: The Utah AIS Management Plan will facilitate opportunity to apply contemporary natural resource management practices in order to regulate, control and eradicate AIS, allowing rehabilitation of infested areas followed by documented monitoring of success in all phases of management.

- **Plan Development Strategy:** Utah Division of Wildlife Resources will prepare, implement and maintain a Utah Aquatic Invasive Species Management Plan, including periodic updates as scientific information evolves regarding AIS management, in concurrence with the Utah Aquatic

Invasive Species Task Force and the U.S. Fish and Wildlife Service's national Aquatic Nuisance Species Task Force.

- **Public Review Strategy:** Utah Division of Wildlife Resources subjected the draft Utah Aquatic Invasive Species Management Plan to a public review process that included Utah Division of Wildlife Resources' five Regional Advisory Councils located throughout Utah, approval by the Utah Wildlife Board (Appendix G). Once approved by the Utah Wildlife Board occurred, approval by the Utah Governor's Office was secure. Then, ultimate approval by the U.S. Fish and Wildlife Service's national Aquatic Nuisance Species Task Force ensued.

The Utah Wildlife Board via the five regional advisory councils, as a matter of normal procedure, will re-review the plan every five years once it is approved.

- **Implementation Strategy:** Utah Division of Wildlife Resources will work with Utah's Department of Natural Resources, Utah's Legislature, Utah AIS Task Force and other natural resource management entities to secure adequate funding and cooperation for plan implementation and continuance.
- **Research and Technology Strategy:** Utah Division of Wildlife Resources has already contracted Utah State University's Fish and Wildlife Department to assist with early detection methodologies. At the onset an array of different methodologies—Deoxyribonucleic Acid polymerase chain reaction test (DNA PCR), spectrographic chromatography comparisons of known values, and protein marker identification--will be compared. Further research will evolve based upon findings and need. It is intended that funds will be secured to maintain a long-term graduate research effort at Utah State University to be directed at AIS issues.

Additionally, Utah Division of Wildlife Resources Fishery Experiment Station, working in concert with Utah's other state fish hatcheries and other research institutions across the nation, perpetually assesses new and different methodologies to protect aquatic animals from AIS.

- **Control and Restoration Strategy:** The control of AIS is problematic to the extent that all the different species require varying approaches. For some species control or containment is poorly understood, although interest across the world is high, so research is ongoing. Findings from that research will be implemented as appropriate and practicable in Utah. The strongest control approach is to simply focus upon keeping AIS out of Utah or contained to areas already infested.

Boaters launching in Utah within 30 days from being on an AIS infested water will be requested to self-certify pre-launch that they have either implemented a “do-it-yourself” decontamination protocol or a “professional” decontamination protocol. These are pre-launch requirements in the case of *Dreissena* mussels.

Boaters leaving infested waters in Utah (to date none exist, although Lake Powell is very suspect) will be compelled to decontaminate their watercraft and equipment prior to launching on another water.

Mitigation or restoration of damaged habitats is routine business for Utah Division of Wildlife Resources and its other natural resource management partners, as is the re-stocking of aquatic animals, when appropriate. Best management practices will be employed for every operation.

- **Monitoring and Evaluation Strategy:** Monitoring for invasions of AIS or spread of existing AIS is a significant challenge as compared to monitoring and evaluation for control and restoration work. Utah AIS Task Force members and agencies will keep track of invasions of AIS or spread of existing AIS, documenting change in conditions annually.

Evaluation is for the most part, “cut and dry.” “Did the Utah AIS Task Force successfully keep AIS out of Utah or contained to existing infested areas, and to what degree are control and restoration strategies successful?” Annual reports summarizing AIS work in Utah, including monitoring, will be coordinated and prepared by Utah Division of Wildlife Resources and provided to the U.S. Fish and Wildlife Service’s Regional AIS Coordinator (Bettina Proctor, U.S. Fish and Wildlife Service, Denver, CO) beginning in December 2008.

Utah's AIS Rapid Response Plan

Much of Utah's AIS Management Plan is focused upon preventing new, AIS from arriving and becoming established, or controlling the spread of those that are currently established. However, another important function of this plan is a coordinated rapid response to finds of newly imported AIS or to the spread of already established AIS. In the past, individual agencies worked virtually alone trying to intercept AIS. Heretofore finds of new or spreading invasions of AIS in Utah were often dependent upon chance, and more often than not, reported by an observant public. Responses outside of permitting systems were poorly coordinated, if at all. In the future, finds of AIS will be a result of well executed searches, and a well planned, timely and coordinated response could be expected. As such, this portion of Utah's AIS Management Plan is a series of rapid response protocols adapted and modified in-part from Idaho's 2007 Aquatic Nuisance Species Plan.

The protocols are based upon 10 rapid response objectives as follows:

- Verify reported AIS detection
- Immediately notify relevant natural resource managers and Utah's AIS Task Force
- Define extent of colonization
- Set-up an appropriate interagency response management team, if needed
- Establish internal and external communication systems
- Organize available resources (personnel, equipment, funds, etc.)
- Prevent further spread via quarantine and pathway management
- Apply available or relevant control and containment actions, and seek mitigation
- Institute long-term monitoring
- Evaluate effectiveness and modify the Rapid Response Plan, if needed

Rapid Response Objective 1: Verify Reported AIS Detection

Strategy: The agency that receives or accepts responsibility for handling the initial report for the presence of an AIS must immediately contact Utah Division of Wildlife Resources for assistance to confirm a report's validity and determine an emergency response.

Task 1: Interview the reporter(s) to validate potential AIS detection.

- Record details of the find location such as GPS delineation, name of the water body or stream length number, prominent landmarks, highway mile marker, or other information about where the suspect species was found.
- Collect pertinent contact information for the reporter(s)--name, address, telephone (home, work and cell), and email.
- Secure an estimate of the number, density, and extent for infestation (colonies or number of individuals) of the species found.
- Document the date and time of sighting(s).
- Note other relevant site conditions (access limitations, etc.)

Task 2: Validate AIS identification as soon as possible via a physical sample as follows:

- Obtain a digital or other photograph (with scale indicator), if possible.
- Secure and preserve dead samples of the species, if possible.
- Arrange a site visit, when feasible, by a team of recognized experts.
- If recognized experts cannot feasibly reach the site within 24 hours, arrange to ship samples and other evidence (e.g., photographs) via Express Mail Service. In the case of photographs, digitize and email to the experts.

Note: Prior to shipping samples, obtain guidance from recognized experts, seeking existing protocols regarding handling of the sample (e.g. desired quantity, where and how to collect and deliver the sample, preservatives, refrigeration, etc.).

Task 3: While proceeding with subsequent response activities described below, obtain secondary visual confirmation of AIS identification via a different expert, preferably an expert who can provide definitive confirmation based on genetic or histological analysis.

Rapid Response Objective 2: Immediately notify relevant natural resource managers and Utah's AIS Task Force

Strategy: The agency that receives or accepts responsibility for handling the initial report must immediately ensure that all parties having jurisdiction in response decisions or technical support are quickly engaged. Rapidly inform any other interested parties.

Note: In the case of an interdiction that results in complete destruction of the AIS and a successful decontamination of the introduction vector (e.g. boat or equipment) ensues, file pertinent reports; no further coordination is needed.

Task 1: Within the first 24 hours or as soon as practical after a physical sample is visually confirmed to be an AIS by a recognized expert, notify relevant natural resource managers and Utah's AIS Task Force.

Note: The notification list must be updated at least annually.

Task 2: Secure verification of notifications to confirm that parties on the contact list, did in fact, receive notification (e.g., Internet list server response confirmation requirement, phone call-backs, etc.).

Rapid Response Objective 3: Define Extent of AIS Colonization

Strategy: The appropriate lead agency(s) with authority where the initial AIS sighting(s) occurred, in partnership with other involved agencies and organizations ("response team"), must rapidly determine the extent of colonization for the newly discovered AIS to guide subsequent management decisions, including survey design.

Task 1: Identify a lead monitoring coordinator to maximize the effectiveness of survey efforts by the "response team."

Task 2: Determine geographic extent and demography of AIS infestation, including upstream and downstream areas and connected water bodies. Also survey nearby water bodies with vulnerability to the same vectors.

Task 3: Identify any potential facilities (e.g., hydropower, fish hatcheries, irrigation systems, etc.) that could be impacted by the AIS. In concurrence with

the lead agency for the “response team,” advise operators of their predicament and invite them to become engaged as cooperators with the “response team.”

Task 4: Ensure that surveys are completed and that results are reported through responsible tracking organizations.

Rapid Response Objective 4: Set-up an appropriate interagency “response team,” if needed

Strategy: The appropriate lead agency(s) with authority where the initial AIS sighting(s) occurred, in concurrence with other involved agencies and organizations (“response team”), must use the Incident Command System as a foundation for decision-making processes in order to expedite decision-making, information sharing; avoid duplication; and minimize authority conflicts, while preserving flexibility for adaptive management.

Task 1: Appoint Incident Commander(s).

Note: Where multiple agencies have lead jurisdiction, a unified command structure should be used. The incident commander(s) will serve as the focal point for coordinating implementation of the rapid response plan, and in cooperation with the overall responses team, will establish other components of an Incident Command System organization as needed. Where time allows, the incident commander(s) will seek collaborative decision-making by the entire team of involved response agencies. For a multi-state infestation where there is no initial consensus on the incident commander role, this role will default to the appropriate U.S. Fish and Wildlife Service Regional AIS Coordinator until the relevant authorities in concurrence reach agreement on incident command.

Task 2: The incident commander(s) shall convene a meeting and/or conference call involving the “response team” and any other relevant agencies or cooperators and conduct the following:

- Coordinate “response team” notifications;
- Use the Incident Command System as a foundation for the “response team’s” organization, involving lead representatives of local, tribal, state, provincial, and/or federal governments that have legal authority over the response and interested cooperators, organizing as appropriate by specific Incident Command System staff positions (e.g. safety officer) and divisions (e.g. operations) for the decision-making processes;
- Represent the “response team” to the various agencies;
- Facilitate a decision-making process that considers consensus processes and cascading levels of authority within individual agencies and existing cooperative agreements;
- Facilitate development of “response team” priorities; and
- Establish planning timelines for the “response team’s” priorities (e.g. 2 weeks vs. 2 months vs. 2 years);

Task 3: The incident commander(s) should develop a technical advisory team that includes experts from outside the region to provide advice about “response team” activities and priorities.

Rapid Response Objective 5: Establish internal and external communication systems

Strategy: Incident Commander(s) must develop an information center to ensure consistent and effective communication to interested internal and external stakeholders, including the media and public.

Task 1: Notify and educate affected landowners, and where appropriate, gain their written permission to access property for “response team” activities.

Task 2: Notify and educate potentially affected water users and water-rights holders.

Task 3: Develop a public information strategy, press packets, press release processes, and press conferences.

Task 4: Develop and implement general public education and outreach.

Note: Since there are a variety of educational materials used between regions and states, assure coordination and perhaps agreement during a multi-state infestation on materials to be used.

Rapid Response Objective 6: Organize available resources (personnel, equipment, funds, etc.)

Strategy: Incident Commander(s) in cooperation with the “response team” must provide sufficient resources to initiate control or containment actions and associated activities (including acquisition of required permits).

Task 1: Develop estimates for staffing needs, facilities and equipment, and funding.

Task 2: Identify potential sources for staff, facilities, equipment, and funds.

Task 3: Secure commitments from the “response team” agencies for needed staff, facilities, equipment and funds.

Task 4: Ensure mechanism for dispersal of funds is in place, and when the funds are needed, that flow of dollars occurs expeditiously.

Task 5: If necessary, pursue declarations of emergency by elected officials.

Rapid Response Objective 7: Prevent Further Spread Using Quarantine and Pathway Management

Strategy: Incident Commander(s) and agencies with regulatory jurisdiction must minimize all vectors that might further spread the original infestation.

Task 1: Evaluate risks, dispersal vectors, including movement by humans, fish and wildlife, water traffic, water flow, and other physical processes.

Task 2: Restrict dispersal pathways, where feasible, including the following or similar measures that are suitable for individual species:

- Quarantine any hatcheries or aquaculture operations that are likely to spread the AIS or their larvae via transfers outside the affected watershed(s);
- Quarantine infested water bodies as needed to prevent spread by watercraft or other vectors and follow any existing protocols;
- Assess the likely movement of boats that recently used the infested water body

to identify risk and inspection needs in other water bodies;

- Establish inspection requirements and decontamination protocols for boats and equipment, and provide decontamination opportunity;
- Ensure that AIS “alert” signs are adequately deployed;
- Develop and implement Hazard Analysis and Critical Control Point plans to ensure that local, state, tribal or federal government response personnel do not further spread the original infestation;
- If possible, stop or slow water releases to potentially un-infested sites;
Note: Consider drawing water from below the thermocline; and
- Install physical barriers to affect AIS movement.

Rapid Response Objective 8: Apply available or relevant control and containment actions, and seek mitigation

Strategy: The Incident Commander(s) in collaboration with the “response team” must evaluate management options. After which, the “response team” must proceed with either eradication and control efforts or containment, including mitigation.

Task 1: Decide if eradication is possible based on rapid analysis of population dynamics and pathways of spread. Consider the following:

- Anticipated cost of eradication effort relative to available funding;
- Type of water body (contained lake, main-stem reservoir, tributary reservoir, small stream, large river, estuary, or water diversion facility);
- Type of substrate (e.g., rocks that allow species attachment on their under sides where chemicals may not reach them).
- Extent of population distribution (isolated vs. widespread, coupled with *a priori* assumptions about the spread of the AIS before detection);
- AIS life stage(s) to be treated;
- Amount of water in a lake, reservoir or waterway to be treated. Consider the following:
 1. Potential for the lake or reservoir to be drawn down or river flows to be reduced before treatment;
 2. Inflow sources, including springs, and potential to regulate that inflow;
- Assess circulation patterns in a water body as part of the treatment strategy;
- Determine spreading pattern of AIS population within the water body;
- Assess treatment impacts and needed mitigation regarding state sensitive species or federally listed threatened or endangered species or critical habitats, particularly Section 7 consultation; and
- Consider special status of affected water bodies as follows:
 1. Water use designation (e.g. drinking water);
 2. “Wild and Scenic” river designation;
 3. Wilderness area;
 4. Potential impact to cultural resources;
 5. Department of Defense or other restricted access areas;
 6. Tribal lands;
 7. Clean Water Act 303(d) listing; and
 8. Beneficial Uses of water bodies.

Task 2: If eradication is deemed feasible, select appropriate methods.

Task 3: If eradication is not possible, develop control objectives and design/select appropriate control measures.

Task 4: Obtain relevant permits and regulatory agency concurrence

- Determine the permits and other regulatory reviews required for chosen eradication or control methods, including any applicable emergency provisions;
- Assess modifying any existing permits or develop new permits;
- Assign lead person from each regulatory agency to facilitate permit approval in a timely manner within their respective agency;
- Obtain a Federal Insecticide, Fungicide and Rodenticide Act, Federal Crisis Exemption (e.g., 40 C.F.R. PART 166), if the known or accepted methods of eradication are not currently permitted;
- Determine if an environmental impact statement or environmental assessment is required, and if so, begin that work (use template for environmental assessments where available);
- Secure needed National Pollutant Discharge Elimination System permits, if needed; and
- Initiate Endangered Species Act Section 7 consultations if needed by contacting appropriate U.S. Fish and Wildlife Service field offices.

Task 5: Implement eradication or control/containment strategies and secure mitigation compensation

- Agencies collaborate to coordinate and deploy field resources
- Establish schedule for frequent team meetings to resolve operational issues that cross jurisdictional interests.

Rapid Response Objective 9: Institute Long-Term Monitoring

Strategy: Incident Commander(s) in collaboration with the “response team” must provide data for adaptive management and long-term evaluation efforts.

Task 1: Design a monitoring program to evaluate the status of the AIS.

Monitoring activities should be carried out in coordination with other field operations, such as environmental monitoring to meet permit or other regulatory compliance requirements (e.g. National Pollutant Discharge Elimination System permits).

Task 2: Disseminate findings through an easily accessible, consolidated, coordinated real-time database and list serve (e.g. 100th Meridian Initiative’s website).

Rapid Response Objective 10: Evaluate effectiveness and modify the Rapid Response Plan as needed

Strategy: The “response team,” in order to allow for adaptive management by assuring feedback on the efficacy of response actions and the effectiveness of the Rapid Response Plan, will enhance long-term preparedness for responses to other AIS introductions.

Task 1: Conduct a follow-up evaluation by “response team” organizations and other interest groups to identify opportunities for improving rapid response

capacity. Disseminate “lessons learned” to other interested organizations (e.g. states, 100th Meridian Initiative, regional panels and river basin teams).

Task 2: Revise the Rapid Response Plan and associated documents/guidelines based on evaluation and long-term monitoring results.

Task 3: As resources allow, develop and implement a research plan that evaluates the associated ecological and economic impacts of the AIS invasion, the effectiveness of management interventions, and negative consequences of management interventions beyond that required by permits.

Task 4: Determine the need for long-term funding for the current AIS management effort, and seek this funding as warranted by meeting with state and federal legislators.

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Appendix A

Aquatic Invasive Species That Threaten Utah

From Kent Hawk: I would like to see bullet-like preventions and controls specifically dealing with each AIS and for all user groups. For example, I think a list including each known AIS should be presented here or somewhere in the plan. Some control or prevention activity can be presented with each AIS and accomplished with minimal expense. This will show that the agencies involved in implementing the plan are seriously involved in natural resource stewardship and not just doing this to gather a paycheck. Governmental agencies should not only administer this program to the public, but they should also hold themselves accountable under the same standards. Here's an example. Whirling disease causative spores are spread in the mud by fishermen and vehicles. What does each agency commit to do to prevent its further spread? Along with the routine outreach to the fisherman and other public, each governmental agency involved with natural resources should commit to something as simple as requiring the washing of their vehicles after they have left an area endemic to whirling disease and before entering another area. If the public is required to decontaminate a boat after leaving a contaminated site, then the vehicle operated by the government sector should be cleaned after leaving a contaminated area also. "What's good for the goose.....".

- A. Aquatic invasive species (AIS) are not strangers to Utah. In fact many species now inhabit Utah and others threaten the state with immediate arrival. The list frequently grows with discoveries of new species or new threats, and it includes pathogens (2), fungi (1), algae (1), plants (3), mollusks (11), fish (3), amphibians (4), and reptiles (2). Their biographic accounts follow and the accounts are arranged in phylogenetic order.

Aquascaping (Crystal Stock--done)

Aquarium dumping (Dan Keller--done)

Bait Releases (E.Freeman--done)

Pathogens

Whirling Disease (C.Wilson or designee)

Viral Hemorrhagic Septicemia (C.Wilson or designee)

Private Aquaculture (T.Miles & L.Dalton)

Fungi and Algae

Reference authority ????? (intro L.Dalton)

Chytrid fungus (*Batrachochytrium dendrobatidis*) (E.Freeman)

Ecology: Chytrid fungus is responsible for a deadly amphibian disease known as Chytridomycosis. The origin of this fungus is unknown. The spores of this fungus attack the keratin in frog skin. Due to a frog or toads ability to breath and drink through its skin, this attack of the skin makes it very difficult to perform these tasks. These fungal spores can also damage the nervous system of the victim, which affects the frog's behavior.

There are several signs to look for when trying to determine if you have an affected frog. They can have discoloration of the skin, usually having a reddish hue. There can be peeling or sloughing on the outside layers of the skin. Another skin related symptom can be the frog's skin having a rough texture instead of being smooth to the touch. Infected individuals tend to be very sluggish with no perceived appetite. They also tend to sit out in the open, seemingly having no intent of protecting itself by hiding. Another characteristic of infected frogs is the lack of ability to hold their limbs close to their bodies. In extreme cases the frog's legs actually trail behind the body.

Distribution: This fungus is found worldwide. It is presently found in Australia, Africa, North, Central and South America, Europe, New Zealand and Oceania. It is presently found in various portions of the United States including Utah. The potential for the fungus to be found throughout the US is very high.

Pathways of Introduction: It is not known how Chytrid fungus came to the United States and spread so effectively. Museum specimens from Colorado and California show that the fungus has been here since at least the 1970's. There are several vectors that can spread the fungus. Humans are a major factor in the spread of this fungus. We can pick up the fungus unknowingly from an infested area and transport it to a new area if we do not decontaminate equipment. Migratory birds and other animals can also transport the spores to new sites after picking up the spores in infected waters. The frogs themselves act as a vector moving the spores to new waters as they travel throughout their range.

Management Considerations: There is no known way in which to eradicate Chytrid fungus from the wild. Decontamination of equipment is the best practice in helping to halt the spread of this fungus. Spraying down all equipment with 409 cleaner and then letting it dry in the sun effectively kills the spores. There are currently ongoing research projects working with anti-fungal agents, but there have been no definitive results at the current time.

Chytrid Fungus
Batrachochytrium dendrobatidis



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(February 2008)

Rock Snot (*Didymosphenia geminata*) (D.Keller)



Photo by Sarah Spaulding, USGS and EPA

Didymo covers approximately 50 percent of the substrate in this image from Rock Creek, Utah.

Ecology: Rock Snot is a diatom, which is a type of single-celled algae. Diatoms are remarkable organisms, unique for their silica (SiO_2) cell walls. Diatoms are found in nearly every freshwater and marine aquatic habitat and contribute a large percentage of the global carbon budget through photosynthesis. *D. geminata* is made up of cells that cannot be seen with the naked eye until large colonies form. It only needs one of these cells to be transported for the algae to spread (Biosecurity NZ, 2005). In both oceans and freshwaters, diatoms are one of the major groups of organisms within the plankton (including other algae, bacteria, and protozoa) and also grow attached to surfaces. The life history of diatoms includes both vegetative and sexual reproduction (reviewed in Edlund & Stoermer 1997), although the sexual stage has not been documented in *D. geminata* (but see Skabichevsky 1983). *D. geminata* cells possess a raphe, a structure that allows the cells to move on surfaces. The cells also have an apical porefield, through which a mucopolysaccharide stalk is secreted. The stalk may attach to rocks, plants, or any other submerged substrate. When the diatom cell divides (i.e. vegetative reproduction), the stalk also divides, eventually forming a dense mass of branching stalks. It is not the diatom cell itself that is responsible for the negative impacts of *D. geminata*, but the massive production of extracellular stalk. Extra cellular polymeric substances (EPS) that comprise the stalk are predominantly composed of polysaccharides and protein. They are complex, multi-layered structures that are resistant to degradation. The degree to which internal (genetic) and external (environmental) change initiates the high level of stalk production is unknown, yet resolving the mechanisms of stalk production is crucial for determining ecological impacts, physiological regulation, and control of *D. geminata*. Currently little is known of the biology and ecological roles of *D. geminata*, and we need

basic information to determine the causes and conditions that lead to nuisance blooms and the geographic expansion of this diatom.

Distribution: Known locations in Utah include Cottonwood Gulch near Joes Valley Reservoir, and Rock Creek on the south slope of the Uinta Mountains. The enclosed map shows distribution within the United States.

Invasion pathways: The mechanisms for *D. geminata* to expand its range to new watersheds are not well understood. Early suggestions that increases in UV-B radiation was tied to the expansion were not supported (Sherbot & Bothwell 1993, Wellnitz et al. 1996, Rader & Belish 1997). Recent work illustrates the capacity of *D. geminata* to survive outside of the stream environment as well as potential vectors in its spread. Cells are able to survive and remain viable in cool, damp, dark conditions for at least 40 days (Kilroy 2005). Fishing equipment, boot tops, neoprene waders, and felt-soles in particular, all provide a site where cells remain viable, at least during short-term studies (Kilroy et al. 2006). At the same time, prime destinations for fishing are becoming more popular with anglers. Rather than frequent a favorite local fishing site, it is now common that anglers travel to multiple, or distant destinations for fishing vacations. Moreover, they may be fishing in a river less than twenty-four hours after leaving their local rivers in North America, and unknowingly spreading *D. geminata*.

The arrival of *D. geminata* in New Zealand in 2004 indicates that it most likely arrived via human-assisted means, for example on footwear, fishing equipment, boats, etc. (Kilroy, 2004).

It is possible that clumps of *D. geminata* could pass through the guts of birds or other animals, or on the feet or feathers/fur of birds and animals (Atkinson, 1980; Kociolek and Spaulding, 2000; in Kilroy, 2004). Wind dispersal of mucilaginous material (the stalks) of *D. geminata* could occur over short distances (Kilroy, 2004).

Management Considerations: New Zealand is currently pursuing a series of experimental trials to test biocides for possible control of *D. geminata* within streams and rivers in New Zealand (Jellyman et al. 2006). In order to test the effectiveness of various biocides, *D. geminata* was grown on artificial substrates and placed in experimental stream channels. Numerous biocides were tested on *D. geminata*. The mats were exposed to each biocide for a period of one hour and the viability of algal cells determined at various time periods, up to 28 days after treatment. Mortality of fish in the experimental stream channels was also assessed. Of the five biocides tested, chelated copper had the greatest negative effect on *D. geminata* for all contact times. In the next stages, the tolerance limits of fish to chelated copper will be established. Although copper compounds have a long history of use as algaecides in the United States, in lakes, reservoirs, and to a lesser extent, flowing waters, they have not been evaluated for control of *D. geminata* outside of New Zealand.

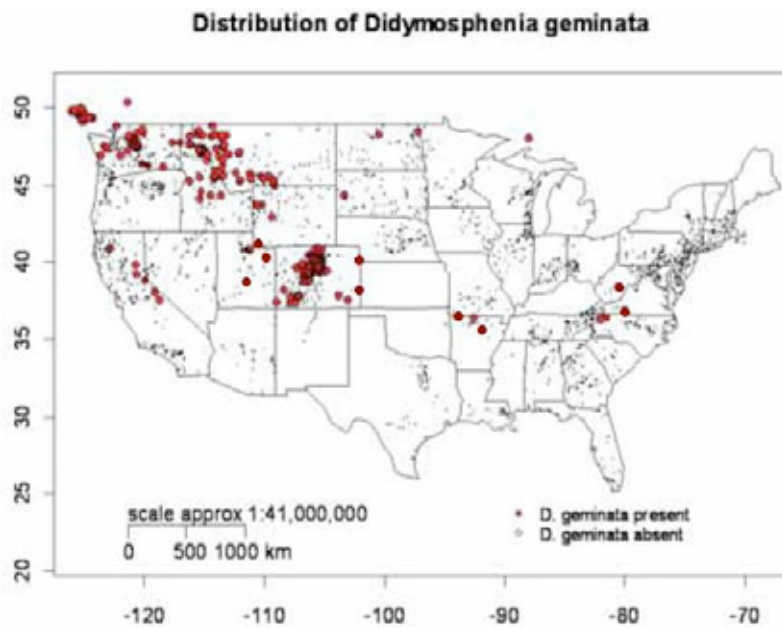
While *D. geminata* is not considered invasive in the United States, the diatom's nuisance blooms has economic impacts. The human population of western United States is closely

dependent on a system of canals to transport water for hydropower generation, agriculture, and human consumption. Nuisance algae, including *D. geminata*, regularly thrive on the stable substrate and flow regime of canal systems (Pryfogle et al. 1997). In some canal systems, managers implement regular removals by scraping *D. geminata* growths from the concrete surfaces of canals.

Didymosphenia geminata is often reported by recreationalists to land managers as being unsightly. The stalks are often mistaken for raw sewage, leading homeowners and recreationalists to complain to local water treatment plants. Many communities rely on tourism dollars that are generated by outdoor recreation. Natural resource opportunities represent important economic value, yet they may be vulnerable to damage by the spread of this nuisance species.

An aggressive education and outreach program is required to change water resource user behavior in order to minimize spread of *D. geminata* on a global scale.

A public awareness campaign, directed at freshwater anglers, boaters, professional guides, and other recreationalists must be integrated with existing invasive species programs. Freshwater resource users, including ecologists, water managers, fisheries biologists, and other scientists, need to be aware of the threat and should practice decontamination procedures to prevent the spread.



Aquatic Plants

Reference authority ???, also see Mr. Steve Dewey, USU; he is the author for *Weeds of the West* and may have online database ([intro J.Polloczek](#))

Common Reed (*Phragmites australis*) ([J.Polloczek](#))

Ecology: *Phragmites* is a tall, perennial, sod forming grass or reed (Uchytel 1992; Amsberry et al. 2000). Long pointed leaves grow from thick vertical stalks and flowers form dense clusters that create a plume-like flower head tawny in color (ISSG 2006). *Phragmites* forms dense monodominant stands along marshes and shorelines (Uchytel 1992). These dense stands of tall reeds crowd native plants, displace native wetland vegetation and alter nutrient cycling (Saltonstall 2002; Windham and Ehrenfeld 2003). These changes alter the structure and function of some marshes and can threaten wildlife populations (Roman et al. 1984).

The common reed reproduces both by seed and vegetative means. Seeds are dispersed by wind and water and can persist in the marsh following a draw down as part of the seed bank. Most reproduction, however, is vegetative through the use of an extensive network of rhizomes and stolons (Smith and Kadlec 1983).

Distribution: *Phragmites* is native to North America and found in every U.S. state (U.S. Army Corps of Engineers 2004). The rapid increase of *Phragmites* in North American wetlands, however, is due to colonization by a more aggressive European variant of the plant (Saltonstall 2002). *Phragmites* is now common to wetland areas and canals throughout most of Utah (USDA, NRCS 2008).

Pathway of Introduction: Once established, *Phragmites* spreads rapidly by means of rhizomes or stolons (Uchytel 1992). *Phragmites* can spread up to 15 or 20 feet per year from vegetative spread alone. The flooding of the Great Salt Lake in the 1980's is believed to be an important factor in the dramatic increase of *Phragmites* around the eastern shore of the Great Salt Lake (personal communication with Val Bachman, Area Waterfowl Manager). Increased physical disturbances in marshes can initiate and accelerate expansion such as disturbances by foot traffic and floating debris (Amsberry et al. 2000).

Management Considerations: Currently there are 26 herbivores in North America known to attack *P. australis* (Tewksbury et al., 2002). Only five of these herbivores are believed to be native. Within this group only the Yuma skipper, *Ochlodes yuma*, a dolichopodid fly in the genus *Thrypticus*; and a gall midge, *Calamomyia phragmites*, are considered native and monophagous on *P. australis* (Tewksbury et al. 2002). Possible biocontrol species are being tested, but are not currently available (Blossey 2003).

Only mechanical and chemical control methods are available at this time for management of *Phragmites*. Mechanical control includes plowing, crushing, mowing, dredging and burning. Mechanical control methods that break up plant matter should be used with caution as they have the potential to increase vegetative spread. Prescribed burning can be successful only if root burn occurs. Burning is recommended during the summer when carbohydrate reserves in the plant are low and when the soil is dry for maximum root burn (Uchytel 1992). Burning removes accumulated *Phragmites* leaf litter, allowing the seeds of other species adequate area to germinate (Marks et al. 1993). Complete removal of *Phragmites* by burning alone, however, is difficult and the practice is typically coupled with herbicide treatment and/or water draw downs.

The U.S. Army Corps of Engineers suggests a glyphosphate such as Rodeo® or Imazapyr, Arsenal® as possible herbicide control. Rodeo® should be applied during late summer or fall when plants are actively growing and in full bloom. Arsenal® is nonselective and will kill other desirable plants. The 2, 4-D herbicides (SEE 2, 4-D, Weed Rhap A-6D, and Weedar 64) are also registered for use on canals or ditch banks in Utah (U.S. Army Corps of Engineers 2004). The Division of Wildlife Resources is actively using a combination of glyphosphate herbicides and prescribed burning to control *Phragmites* along the eastern shore of the Great Salt Lake.

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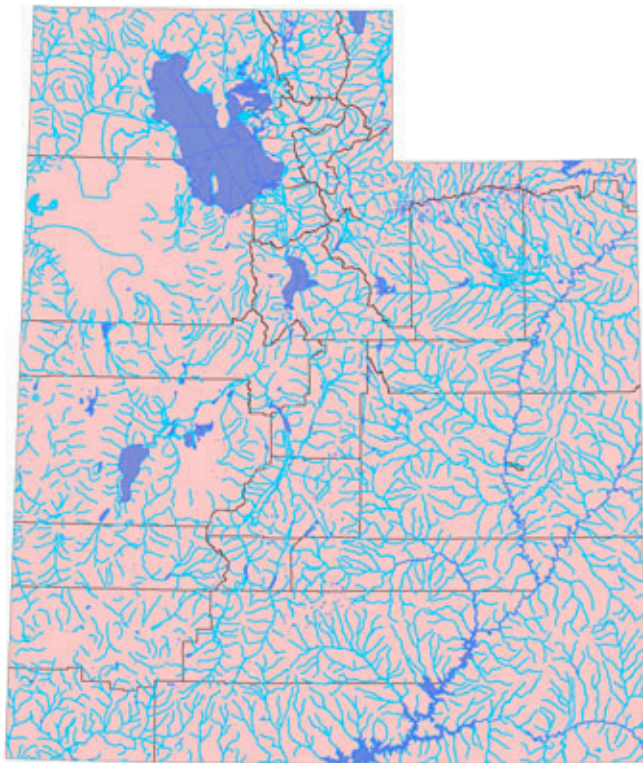
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Common Reed

Counties the Common Reed is present.
Major Waterways



Richard Old
XID Services, Inc.,
Bugwood.org

Tamarisk (J.Polloczek)

Purple loosestrife (*Lythrum salicaria*) (J.Polloczek)

Ecology: Purple Loosestrife is an emergent, rhizomatous, perennial with erect stems. The leaves are simple, entire and opposite or whorled with rose-purple flowers consisting of 5 to 7 petals (Whitson et al. 1996). Purple loosestrife prefers aquatic sites along stream banks and shallow ponds, though it has successfully invaded drier regions by utilizing irrigation canals and waterways as pathways to dispersal (Whitson et al. 1996). *L. salicaria* prefers moist soils of neutral to slightly acid pH, however it is found in a wide range of soil textures and types and is able to adjust to seasonal or semi-permanent changes in water levels (Thompson et al. 1999).

The successful spread of purple loosestrife is attributed to its ability to reproduce through seed or vegetative means, prolific seed production and a wide scope of dispersal mechanisms. A mature plant can produce up to 2.7 million seeds and disturbance to underground stems increases spread by encouraging new growth from adventitious shoots and roots (Thompson et al. 1999).

Purple loosestrife has drastically altered wetlands across North America (Thompson et al. 1999). Once *L. salicaria* is established, it outcompetes and replaces native plants (Gaudet and Keddy 1995) that provide higher quality food and habitat for wildlife (Raloff 1992; Brown et al. 2002). *L. salicaria* forms dense homogeneous stands that restrict native wetland plant species and reduce future reproduction by native plants through competition for pollinators (Thompson 1987; Brown et al. 2002). The recreational and overall aesthetic value of wetlands and waterways is diminished as dense stands of *L. salicaria* choke waterways and decrease biodiversity.

Distribution: Purple Loosestrife is of Eurasian origin and has been established in North America since the early 1800's. This species has expanded its distribution from its point of introduction in the northeast to the western U.S. and north into Canada (Thompson et al. 1999). Purple loosestrife currently inhabits 43 of the 48 contiguous states and is prevalent in Utah's northern wetland areas (Sturtevant 2008).

Pathways of Introduction: Purple loosestrife spreads downstream through water dispersal of seeds and vegetative matter. Seeds are unintentionally transported and spread with wetland soil carried by animals, humans, boats and vehicles (Thompson et al. 1999). Purple loosestrife is also widely sold as an ornamental in states where regulations do not prohibit its sale and distribution. In Utah, purple loosestrife is listed as a noxious weed and its sale is prohibited.

Management considerations: The best control measure, as with many invasive plants, is to preserve a healthy native ecosystem to prevent or slow invasion (ISSG 2006).

Herbicides are the most commonly used method of control for purple loosestrife. Commonly used chemicals include glyphosphate sold as Rodeo® for use in wetlands and Roundup® for use in uplands, 2, 4-D, and Renovate®. However, glyphosphate is nonselective and can kill desirable plants associated with loosestrife if applied carelessly (Butterfield et al. 1996). Multiple chemical treatments are usually required for control as new seedlings emerge annually from the seed bank.

Biological control methods are more effective for long-term control of larger populations of purple loosestrife. In North America four insects have been approved by the U. S. Department of Agriculture for use as biological control agents: the root-mining weevil *Hylobius transversovittatus*, two leaf-feeding beetles *Galerucella californiensis* and *G. pusilla*, and *Nanophyes marmoratus*, a herbivorous weevil. The impact of these introduced beetles on native, non-target species is considered low. *G. californiensis* has provided successful control of purple loosestrife (Malecki and Blossey 1993).

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Purple Loosestrife

Counties purple loosestrife is present.
Major Waterways



Paul Champion, NIWA

Eurasian Water Milfoil ([J.Polloczek](#))

Curly Pond Weed ([J.Polloczek](#))

Invertebrates

Reference [Utah Comprehensive Wildlife Conservation Strategy \(Wildlife Action Plan\)](#) noting that non-native fish species compete with either Tier I (T&E), Tier II (species of conservation concern) or Tier III (species with at-risk habitats) native species and cite (1) Utah Wildlife Code, and (2) Collection, Importation & Possession of Zoological Animals as authorities. ([intro L.Dalton](#))

Mollusks

New Zealand mudsnail (*Potamopyrgus antipodarum*) ([J.Polloczek](#))

Ecology: *P. antipodarum* is a small (<5mm) invasive, hydrobiid snail. It has an elongate, dextral shell that varies in color and typically has 5 to 6 whorls at maturity (Gustafson 2005). New Zealand mudsnails (NZMS) are able to invade and grow in a wide range of ecological habitats. They are found in rivers, reservoirs, lakes, and estuaries and are able to adapt to a wide range of temperature, salinities and substrates (Zaranko et al. 1997; Richards et al. 2001; Hall et al. 2003). NZMS are not able to withstand freezing temperatures at any salinity (Hylleberg and Siegmund 1987). The highest densities of NZMS typically occur in systems with high primary productivity, constant temperatures and constant flow (Gustafson 2005).

Reproductive, behavioral and morphological adaptations have made NZMS an ideal aggressive invasive species. Their rapid spread is attributed to high reproductive and growth rates, parthenogenesis and lack of parental care. A single female can theoretically produce up to 3.125×10^8 snails in one year. The ability for this species to reproduce asexually means that it is possible for a single individual to produce a new population (Zaranko et al. 1997). The presence of an operculum also allows them to survive for several weeks out of water (Bowler 1991).

NZMS are shown to negatively impact the aquatic communities they invade. Hall et al. (2003) found NZMS population densities that exceeded 100,000 individuals per square meter and consumed 75% of the gross primary production. NZMS outcompete native invertebrates for food and space and have also been shown to contribute to weight loss in fish when consumed (Bowler 1991; Vinson and Baker 2007). There is also concern that the high densities of NZMS could produce biofouling in facilities that become infested (Zaranko et al. 1997).

Distribution: *P. antipodarum* has spread from New Zealand to freshwater environments throughout the world. This species current distribution includes: Australia, Europe, Asia, and North America. First discovered in the United States in 1987 in the Snake River near Hagerman, Idaho; NZMS are now locally abundant in western rivers (Bowler 1991; Dybdahl and Kane 2005). In Utah, NZMS are found in most of the major river drainages of the northern part of the state and in the Green River (Gustafson 2005; Harju 2007).

Pathways of Introduction: The original source of introduction is unknown, though it is speculated that NZMS was introduced through the commercial transport of aquaculture

products (Bowler 1991). Since introduction, both active and passive transport methods have contributed to its spread. NZMS have been shown to spread independently upstream through locomotion. Passive spread by birds, through the alimentary canal of fish, and contaminated recreational equipment is also documented (Haynes et al. 1985; Richards et al. 2004; New Zealand Mudsnaill Management and Control Plan Working Group 2006).

Management considerations: Spread of NZMS can be prevented through increased public education efforts. NZMS have no resistant stage or adhesive structures like other aquatic nuisance species and simple preventative measures can reduce their likelihood of spread to new areas. Once established, however, NZMS are extremely difficult to remove. The spread of NZMS into new watersheds is primarily through unintentional human transport on contaminated recreational equipment, water containers and bait buckets. (Richards 2002). Desiccation and freezing may be used to decontaminate angling and other recreational equipment that comes in contact with water, but this method can be slow, taking up to 24 hours. A faster (less than 30 minutes) and more effective alternative is to spray or immerse gear in disinfectant baths of: copper sulfate, benzethonium chloride, Formula 409® or Sparquat® (Hosea and Finlayson 2005; New Zealand Mudsnaill Management and Control Plan Working Group 2006).

Possible control methods of existing populations include periodic molluscicide application, desiccation of the waterbody, and introduction of a biological control agent. GreenClean® is a non-copper-based algaecide that has been successful at killing NZMS in lab experiments and is being tested for field applications (New Zealand Mudsnaill Management and Control Plan Working Group 2006). Biocontrol lab trials using a trematode parasite from the native range of New Zealand mudsnails have been positive so far (Dybdahl et al. 2005), though this method of control is currently unavailable.

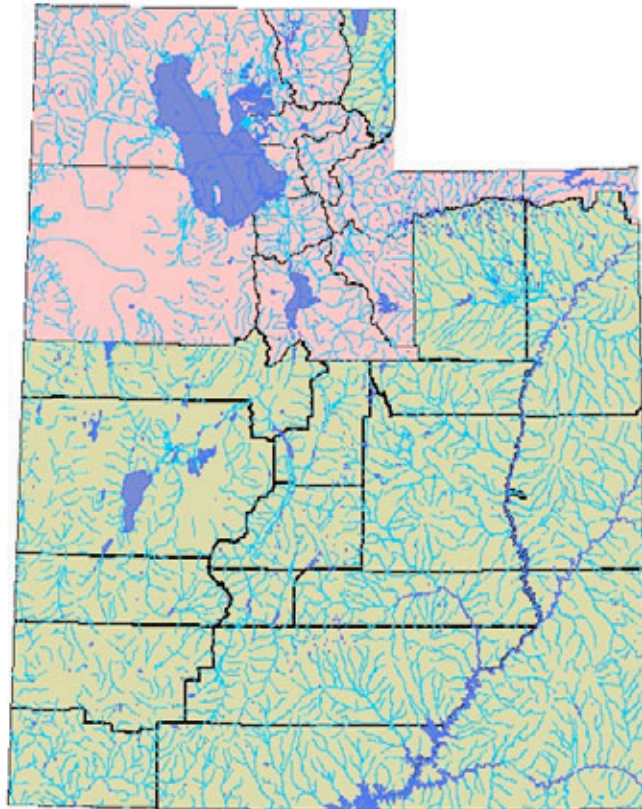
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New Zealand Mudsnail

— Major Waterways
 ■ Counties New Zealand mudsnail is present.



Daniel L. Gustafson
 Montana State University

Red-rimmed Melania (*Melanoides tuberculatus*) (E.Freeman)

Ecology: This is a small, aquatic, herbivorous snail, consuming detritus and benthic microalgae. Adult snails typically attain a shell length of between 30 and 36mm, however there have been reports of snails achieving lengths up to 80mm. It has an

elongated conical shell with regularly increasing whorls. Five whorls typically make up the shell. There are prominent vertical ribs present on the middle and upper whorls. The spiral of the shell is usually twice the length of the aperture or more. Shell coloration is usually light brown, frequently mottled with rust colored spots that may form a spiral below the suture.

Red-rimmed *Melania* is very common throughout its native range in both Africa and Asia. It prefers shallow, slow running water (0.6 – 1.2 cfs). This snail tolerates a wide range of saline environments and can be found in fresh water as well as estuarine environments up to 30 ppt. The temperature tolerance for this snail is believed to be restricted in the US to between 18 – 25 degrees Celsius. The prime habitat for this species consists of areas rich in detritus and silt behind overhanging stems and protruding roots of bank vegetation. They are active mostly at night, hiding beneath decaying plants and stones or burying themselves in the mud during the day.

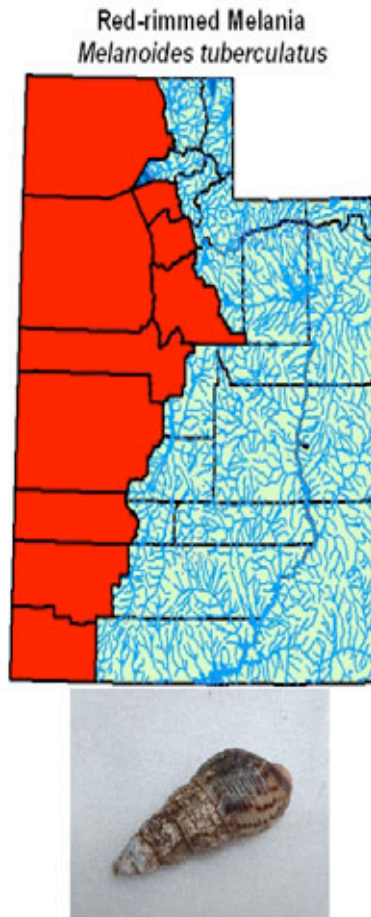
Red-rimmed *Melania* reproduce both sexually and through parthenogenesis. Individual snails as small as 10mm are able to reproduce. This species is viviparous having up to 70 offspring held in a brood pouch. They remain in the brood pouch until released at 1 – 2mm in length.

Red-rimmed *Melania* is also a vector for several important diseases. They are intermediate host for a number of trematode parasites including: *Clonorchis sinensis*, the Chinese liver fluke; *Paragonimus westermani*, the Oriental lung fluke; *Diorchitrema formosanum*, and intestinal trematode; *Opisthorchis sinensis*, the human liver fluke; and *Philophthalmus sp.*, the avian eye fluke.

Distribution: Native to subtropical and tropical regions of northern and eastern African and southern Asia from Morocco and Madagascar to Saudi Arabia, Iran, Pakistan, India, southern China, and Indonesia east to Java and Celebes. In the United States it is widely distributed throughout the Gulf of Mexico ecosystem. A San Francisco aquarium dealer prior to 1937 introduced it into California. It was then introduced into Tampa Bay, Florida after purchase from the same San Francisco aquarium dealer. There are a number of springs throughout the Great Basin that either have Red-rimmed *Melania* or are suitable for their survival.

Pathways of Introduction: The original method of introduction to the United States was through the aquarium trade. It is likely that this is how it was spread to the Great Basin, including Utah. Fisherman using felt-soled waders as they move from one site to the next without decontaminating their equipment can move it throughout Utah.

Management Consideration: Once these snails have been introduced into a new body of water it is unlikely to remove them. The best method for preventing the spread of this species into new waters is to decontaminate all equipment that has come in contact with infested waters. This can be done with scalding hot water or an easier method of spraying equipment down with 409 cleaner and letting the equipment dry in the sun.



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Chinese mysterysnail (E.Freeman)

Asian Clam (*Corbicula fluminea*) (D.Keller)

Description: The outside of the shell is normally yellow-brown with concentric rings. The color can flake, leaving white spots. The inside of the shells are pearl to purple in color. Although the Asian clam grows and disperses less rapidly than the zebra mussel, it too is causing considerable fouling problems and is threatening native species. Costs associated with its fouling damage are about \$1 billion/yr (Isom 1986; OTA 1993).

Ecology: Asian clams are bi-valve filter feeders that remove particles (plankton) from the water column. They can be found at the sediment surface or slightly buried. The ability to reproduce rapidly coupled with low tolerance of cold temperatures can produce wild swings in population sizes from year to year in northern water bodies. *C. fluminea* is found both in lotic and lentic habitats over its native range in southeastern Asia. In the United States it has been most successful in well-oxygenated clear waters (Belanger et al., 1985; Stites et al., 1995). Maximum Asian clam density has been reported to vary between 1000/m² (Gottfried and Osborne, 1982; Stites et al., 1995) to 6000/ft² (Sinclair, 1971a) and even 25,000/ft² (Sinclair, 1971b). Life span varies according to habitat, with a maximum life span of approximately 7 years (Hall, 1984). They can self fertilize and release up to 2,000 juveniles per day, and more than 100,000 in a lifetime. Juveniles are only 1mm long when discharged and take one to four years to reach maturity. At this time they are about one centimeter long. Adults can reach a length of about 5 cm. Usually *C. fluminea* is more common and occurs at higher densities in stream pools than in stream runs (Blalock and Herod, 1999). Fine clean sand, clay, and coarse sand are preferred substrates, although they may be found in lower numbers on most any substrate (Gottfried, and Osborne, 1982; Belanger et al., 1985; Blalock and Herod, 1999).

Asian clams can tolerate salinities of up to 13ppt for short periods of time. If allowed to acclimate, they may tolerate salinities as high as 24ppt (King et al., 1986). Optimum is at lower salinities (Morton and Tong, 1985). In nature, Asian clams occur mostly in freshwaters, however, they have been reported from brackish and estuarine habitats, but are typically not as abundant in such habitats as in freshwaters (Carlton, 1992).

This species appears to tolerate low temperatures well. Viable populations have been reported surviving temperatures of 0-2°C over winter in the Clinton River, Michigan (Janech and Hunter, 1984). However, low temperatures do limit reproduction, since veligers are typically released at temperatures of 16°C or higher (Hall, 1984).

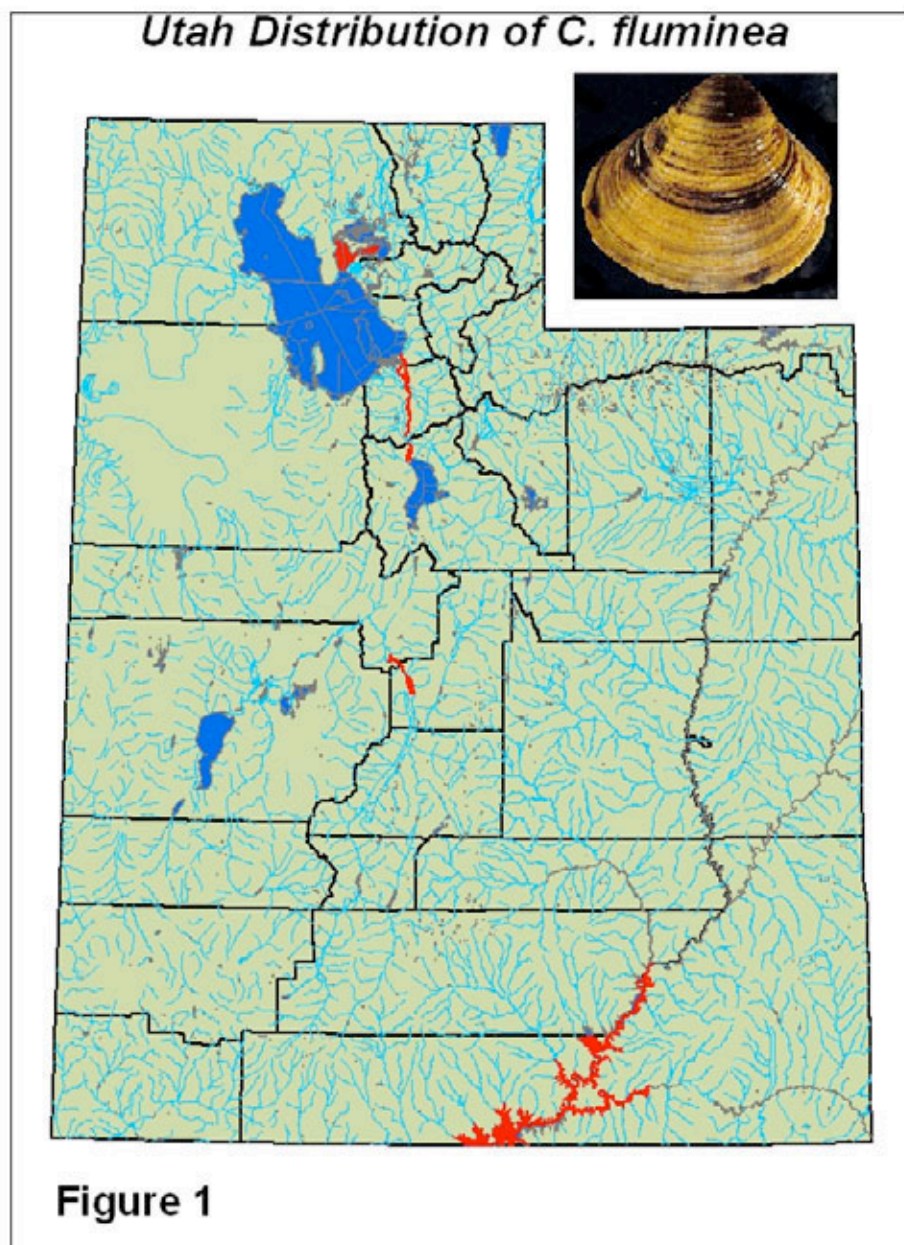
Distribution: The first collection of *C. fluminea* in the United States was recorded in 1938 along the banks of the Columbia River near Knappton, Washington (Counts 1986).

Currently it is found in 38 states and the District of Columbia. In Utah, Asian clams have been established in Lake Powell since the mid 1970's. It is likely they were present in the Colorado River prior to completion of the Glen Canyon Dam in 1960. Recently they have been found at various locations along the Jordan River, which flows from Utah Lake, into the Great Salt Lake. The Jordan River provides water to a significant canal system, so the clams are likely all over Utah Valley and the Salt Lake Valley, which is where most of Utah's 2.5 million people live. Utah Lake is an essential element of the Central Utah Project, receiving water as a trans-basin diversion from the Colorado River drainage via Strawberry Reservoir. The reservoir receives water from 10 south slope Uinta Mountain drainages via an extensive underground collection system. Those drainages would have eventually entered the Green River and the Colorado River, which drain to Lake Powell. The fouling effects of Asian clams will likely create problems within this system. *C. fluminea* was confirmed in Willard Bay (both its inflow and outflow) in the Spring of 2007; it receives water from the Weber River. This species is also found in Yuba Reservoir in south central Utah. (See figure 1 for Utah distribution.)

Pathways of Introduction: *C. fluminea* was thought to have first entered the United States as a food item. Humans are the primary agent of dispersal. They are thought to spread primarily through activity such as bait bucket introductions, accidental introductions associated with imported aquaculture species, and intentional introductions by people who buy or sell them as a food item in markets. The only other significant dispersal agents are water currents or flooding events.

Management Considerations: *C. fluminea* populations are controlled by a variety of methods. Where intakes pipes are fouled, thermal regulation is employed, whereby water in the pipes is heated to temperatures exceeding 37 degrees Celsius. But this method is not feasible in most existing water systems. Mechanical methods, such as using screens and traps, can effectively dispose of older clams and remove body tissue and shells from the system. Chemicals, such as small concentrations of chlorine or bromine, are used to kill juveniles and sometimes adults. This method is very effective, but because of increasing restrictions on the amounts of these chemicals that may be released from a facility, managers have been moving away from this method.

Literature Cited:



Crayfish (D.Keller)

Utah has three know species of invasive crayfish. These species are the northern crayfish (*Orconectes virilis*), Louisiana/red swamp crayfish (*Procambarus clarkii*) and the pacific crayfish (*Pacifasacus leniusculus*). Another species of concern is the water nymph crayfish (*Orconectes nais*). This crayfish is currently not found in Utah; however, it has

heavily infested Colorado waters. Due to its distribution on the western slope of Colorado it is likely that it will invade Utah waters. Rusty crayfish, (*Orconectes rusticus*) is also not found in Utah but poses a threat due to its wide North American distribution and its popularity among anglers as bait. Environmental impacts of crayfish introductions can be positive, negative or neutral. However, non-native crayfish introductions have shown the potential to negatively impact ecosystems and cause economic damage. Negative effects of non-native crayfish introductions include displacement of native crayfish species, transfer of disease, consumption of fish eggs, reduction of fish stocks, consumption of large amounts of macrophytes, indirect and direct effects on other invertebrates and destabilizing ditches, canals, and stream banks. Utah has one know native crayfish, (*Pacifastacus gambelii*); it is likely that any non-native crayfish introduction would place this species at risk. Law enforcement designed to prevent the spread of crayfish has proven difficult (many people intentionally spread crayfish to enhance recreational sport/cray-fishing). The best method of control is to prevent their introduction. Educating anglers, crayfish trappers, bait dealers, and teachers about the threats posed by invasive crayfish will help reduce the risk of spreading.

Northern crayfish (*Orconectes virilis*)



Photo Credit: Keith A. Crandall

Description: According to Collicut (1998), *O. virilis* grows to a length of about 10-12 cm, not including the 2 pairs of long antennae or the large chelipeds (the large pincer bearing legs) that extend forward. Chelipeds often have a bluish tint, particularly in males, which have larger chelipeds and pincers than females. The head and thorax are covered by a shell-like carapace that is usually brownish to rusty red in color. They are found in permanent bodies of water deep enough not to freeze solid or experience low oxygen levels. *O. virilis* requires shelter in the form of rocks, logs, or thick vegetation in which to hide from predators during daylight hours.

Ecology: *O. virilis* eats some aquatic plants as well as invertebrates, such as snails and insects; it also eats tadpoles and small fish. They are probably best described as opportunistic omnivores consuming whatever they can catch. While they can catch some quick moving prey like tadpoles or fish, they probably obtain most of their food by scavenging dead animals.

O. virilis can mate in autumn or in spring. However, the eggs are not fertilized and laid

until spring. Females can store sperm from a fall mating and protect their eggs by carrying them under their tails. Eggs are attached to swimmerets in a large ball resembling a raspberry. The eggs hatch one to two months after they are laid. Young hatchlings look like miniature adults and can probably grow to about 2-3 cm long by the fall. *O. virilis* has a short lifespan. Males usually die after mating when they are about 2 years old. The females die after their young hatch, also at about 2 years of age. *O. virilis* occasionally lives longer, but it's thought that none survive beyond their 4th spring. (Collicut 1998)

Distribution: (figure 1,Utah distribution).

Invasion pathways to new locations: Aquaculture: Crayfish are harvested from natural waters by commercial fishers and anglers or cultivated in small earthen ponds (Huner, 1997).

Live food trade: Crayfishes have been most commonly used as food and fish bait but are also commercially exploited in the pet trade as pets and food for predaceous pet fishes.

Management information: *O. virilis* is of serious concern because its burrows in ditches and levee banks may disrupt irrigation networks. *O. virilis'* burrowing and swimming activities may also muddy the water, reducing photosynthesis in submerged plants. (Godfrey, 2002)

Literature Cited:

Louisiana/red swamp crayfish (*Procambarus clarkii*)



Description: Usually colored a dark red, *P. clarkii* is capable of reaching sizes in excess of 50g in 3-5 months. Adults reach about 5.5 to 12 cms (2.2 to 4.7 inches) in length.

Ecology: Unlike the native crayfish species of Europe *P. clarkii* is able to tolerate dry periods of up to four months (Henttonen and Huner, 1999; Ackefors, 1999). Because of this, it is able to occupy a wide variety of habitats, including subterranean situations, wet meadows, seasonally flooded swamps and marshes, and permanent lakes and streams. It

thrives in warm, shallow wetland ecosystems. It can even be found in sluggish streams and lentic situations, being tolerant of low oxygen levels and high temperatures. It is one of few North American crayfishes with tolerance for saline waters (NatureServe, 2003).

In laboratory conditions *P. clarkii* preferred macro invertebrates to plant matter, preying largely on species with slow escape reactions (such as *Odonata*, *Ephemeroptera* and snails) and less on species with fast escape reactions, such as live mosquito fish (*Gambusia affinis*). Crayfish may be cannibalistic or prey on individuals of other crayfish species. *P. clarkii* prefers high-protein food (such as freshwater macro invertebrates) because it stimulates a high growth rate but is an opportunistic feeder and will consume plant matter and detritus when its prey is lacking or it is unable to catch prey (Ilhéu and Bernardo, 1993, in Nystrom, 1999).

P. clarkii matures when it reaches a size of between 6 and 12.5 centimeters. A 10 cm female may produce up to 500 eggs, while smaller females may produce around a 100 eggs. The eggs are 0.4mm, notably smaller than those produced by members of the family Astacidae. Newly hatched crayfish remain with their mother in the burrow for up to eight weeks and undergo two moults before they can fend for themselves (Ackefors, 1999). Unlike the European native *Astacus* and *Austropotamobius* species, populations of *P. clarkii* contain individuals that are incubating eggs or carrying young throughout the year (Huner and Barr, 1994, in Lindqvist and Huner, 1999). This allows *P. clarkii* to reproduce at the first available opportunity, which contributes to its colonization success (Huner, 1992, 1995, in Gutierrez-Yurrita and Montes, 1999). In places with a long flooding period (greater than 6 months), there may be at least two reproductive periods (in autumn and spring). The spring period is longer and more prolific and persists until the drying of the marsh. For large females to reproduce it is necessary to have hormonal induction (produced by the photoperiod), a hydroperiod longer than four months, a temperature above 18 °C, and a pH between 7 and 8 (Gutierrez-Yurrita, 1997). If females have only a short period to prepare themselves for reproduction they must prematurely leave their burrow to feed; in such circumstances many females will die of dehydration, bringing about a depression in the population (Huner, 1995; Gutierrez-Yurrita, 1997, in Gutierrez-Yurrita and Montes, 1999).

P. clarkii exhibits a cyclic dimorphism of sexually active and inactive periods alternating during the lifecycle. After the young hatch, metamorphosis takes place, followed by two to three weeks of voracious eating. After this they moult and again assume their immature appearance (Huner and Barr, 1994, in Ackefors, 1999). Egg production can be completed within six weeks, incubation and maternal attachment within three weeks and maturation within eight weeks. Optimal temperatures are 21-27 degrees and growth inhibition occurs at temperatures below 12 degrees Celsius (Ackefors, 1999). *P. clarkii* shows two patterns of activity, a wandering phase, without any daily periodicity, characterized by short peaks of high speed of locomotion, and a longer stationary phase, during which crayfish hide in the burrows by day, emerging only at dusk to forage. Other behaviors, such as fighting or mating, take place at nighttime. During the wandering phase, breeding males move up to 17 km in four days and cover a wide area. This intensive activity helps dispersion in this species (Gherardi and Barbaresi, 2000).

Distribution: (Figure 1, Utah distribution; Figure 2, North American distribution)

Native range: Northeastern Mexico and the south central USA (Henttonen and Huner, 1999).

Known introduced range: inter-state introductions into at least 15 other states in the USA

Invasion pathways to new locations: Agriculture: *P. clarkii* is a popular dining delicacy, accounting for the vast majority of crayfish commercially produced in the United States (Washington Department of Fish and Wildlife, 2003). It was the most dominant freshwater crayfish in the world during the 20th century and its commercial success led to intentional introductions throughout Spain, France and Italy during the 1970s and 1980s (Henttonen and Huner, 1999).

Natural dispersal: Natural dispersal from Spanish waters are thought to have facilitated the spread of *P. clarkii* into southern Portugal (Henttonen and Huner, 1999).

Other: *P. clarkii* can spread to new areas by anglers using them as bait. Popular as a bait species for largemouth bass, this is believed to have been the most likely cause for their introduction into Washington (The Washington Department of Fish and Wildlife, 2003).

Pet/aquarium trade: The habit of selling *P. clarkii* alive as an aquarium or garden pond pet may have accelerated the spread of the species through natural waterways in Europe (Henttonen and Huner, 1999).

Smuggling: The crayfish that now occur in African freshwaters are thought to have been introduced without the knowledge and permission of the relevant authorities (Mikkola, 1996, in Holdich, 1999).

Natural dispersal (local): There are reports of migrations of males over several miles in comparatively dry areas, especially in the rainy season (Nature Serve, 2003).

Other (local): *P. clarkii* can spread to new areas by anglers using them as bait (Aquatic Non-native Species Update, 2000).

Management considerations: When introduced into a suitable habitat *P. clarkii* may quickly become established and eventually become a keystone species (a primary contributor to the ecosystem it inhabits). Its introduction may cause dramatic changes to occur in native plant and animal communities (Schleifstein, 2003). For example, *P. clarkii* has contributed to the decline of native European crayfish (in the family Astacidae) by introducing interspecific competition pressure and acting as a vector for the transmission of the crayfish fungus plague, *Aphanomyces astaci*. *P. clarkii* has also been associated with the crayfish virus vibriosis in crayfish farms, and is an intermediate host for numerous helminth parasites of vertebrates (Thune et al., 1991; Hobbs III et al., 1989, in Holdich, 1999). *P. clarkii* also reduces the value of the freshwater habitats in which it occurs by consuming invertebrates and macrophytes and degrading river banks by its burrowing activity (Holdich, 1999).

Possible management options include the elimination (or reduction) of alien crayfish via

mechanical, physical, chemical or biological methods, the restocking of native crayfish populations (threatened by the crayfish plague fungus and interspecific competition with alien species), the development of plague-resistant strains of native crayfish and the use of legislation to prohibit the transport and release of alien crayfish.

Reduction may be possible by physical methods, although eradication is unlikely unless the population is particularly restricted in range and size. All physical methods have environment costs, which should be weighed up against the environmental benefits of employing them. Mechanical methods to control crayfish include the use of traps, seine nets, and electro-fishing. Continued trapping is preferable to short-term intensive trapping, which may provoke feedback responses in the population such as stimulating a younger maturation age and a greater egg production. Physical methods of control include the drainage of ponds, the diversion of rivers and the construction of barriers (either physical or electrical).

Chemicals that can be used to control crayfish include biocides such as organophosphate, organochlorine, and pyrethroid insecticides; individual crayfish are differentially affected depending on their size, with smaller individuals being more susceptible. Since no biocides are crayfish-specific other invertebrates, such as arthropods, may be eliminated along with crayfish, and may subsequently have to be re-introduced. There is cause for concern about toxin bioaccumulation and biomagnification in the food chain (although this is less of a problem with pyrethroids). Another chemical solution lies in the potential to use crayfish-specific, or even species-specific, pheromones to trap animals. This has been used to control insect populations, but has not been researched with respect to crayfish, although crustaceans do use similar pheromones.

Possible biological control methods include the use of fish predators, disease-causing organisms (that infect crayfish) and use of microbes that produce toxins, for example, the bacterium *Bacillus thuringiensis* var. *israeliensis* (Pedigo, 1989, in Holdich et al., 1999). Only the use of predaceous fish has been used successfully; eels, burbot, perch and pike are predators are all partial to crayfish (Westman, 1991, in Holdich et al., 1999). The amount of cover, type of fish predator used and location are all important variables in determining the success of such an approach, and in general reduced coverage is correlated with increased predation rates.

Literature Cited:

Pacific crayfish (*Pacifastacus leniusculus*)

Also known as Californian crayfish or signal crayfish



Description: Its claws are robust and smooth on both surfaces, the underside is red in colour; with a single tubercle on the inner side of the fixed finger; and a white-turquoise patch on top of the junction of fixed and moveable fingers; adult males are massive either lengthways or in width. Males are up to 16 cm in length from tip of rostrum to end of telson, females up to 12 cm; much larger individuals have been recorded, i.e. 95 mm carapace length. The weight is typically 60 and 110 g at 50 and 70 mm carapace length. Its color is bluish-brown to reddish-brown, occasionally light- to dark-brown.

Ecology: *P. leniusculus* occupies a wide range of habitats from small streams to large rivers (e.g. Columbia River) and natural lakes, including sub-alpine lakes, such as Lakes Tahoe and Donner (Lowery & Holdich, 1988; Lewis, 2002). However, it also grows well in culture ponds. It is tolerant of brackish water and high temperatures. It does not occur in waters with a pH lower than 6.0. *P. leniusculus* is very active and migrates up and down rivers, as well as moving overland around obstacles. However, their rate of colonization is relatively slow and may only be about 1 km yr⁻¹. Their burrows can reach high densities, i.e. 14 m⁻¹, and they can have a serious impact on bank morphology, causing them to collapse. It was considered to be a non-burrowing species, but in Europe in constructs burrows under rocks or in river and lake banks (Guan, 1994; Sibley, 2000).

P. leniusculus is a opportunistic feeder, although more animal than plant material may be consumed if available. It can have a considerable impact on populations of macro-invertebrates, benthic fish, and aquatic plants (Guan & Wiles 1997; Nyström, 1999; Lewis, 2002), it also has been used to clear weed from ponds on fish farms. Griffiths et al. (2004) found that the presence of *P. leniusculus* significantly reduced the number of Atlantic salmon using shelters in artificial test arenas. Sooty crayfish have become extinct partly due to interspecific competition with *P. leniusculus*, which was introduced into its range. *P. leniusculus* has also been implicated in causing a reduction in the range of the already narrowly endemic shasta crayfish.

As an opportunistic polytrophic feeder, *P. leniusculus* will eat anything that is available, including other crayfish. The diet was found to shift from aquatic insects in juveniles, to more plant material in adults in some American populations (Lewis, 2002). However, Guan & Wiles (1997) found that cannibalism increased with size and that more animal than plant material was consumed by adults in a British river.

The breeding cycle is typical of a cool temperate zone species, although *P. leniusculus* grows faster and reaches a greater size than its counterparts. Size at maturity is usually 6-9 cm TL at an age of 2-3 years, although maturity can occur as early as 1 year. Mating and egg laying occurs during October in the vast majority of populations. Egg incubation time ranges from 166 to 280 days. In natural populations hatching occurs from late March to the end of July depending on latitude and temperature. Egg numbers usually range from 200 to 400, although some individuals of 66 mm CL have been reported as having over 500 eggs. Based on the use of the lipofuscin technique it has been estimated that some individuals can live 16 years, and other estimates state that it may be as long as 20 years. Some individuals may grow to a large size, i.e. 95 mm CL, but this may not represent a great age, but that of a fast-growing newly introduced population that encounters little competition. Estimates of survivorship to age 2 vary from 10-52%, being dependent on both abiotic and biotic factors. Competition and cannibalism can greatly affect survival in dense populations. Stebbing et al. (2003) demonstrated for the first time the presence of a sex pheromone, released during the breeding season by mature females, that stimulates courtship and mating behavior in male *P. leniusculus*.

P. leniusculus has a typical life cycle of a member of the crayfish family Astacidae, and which is therefore very similar to that of indigenous European crayfish. The eggs hatch into miniature crayfish that stay with the mother for three stages, the third stage gradually becoming more and more independent of the mother. Juveniles undergo as many as 11 moults during their first year, but by age 3 this is reduced to two moults per year, and by age 4 onwards to one moult per year (Lewis, 2002).

Distribution: (Figure 2, North American Distribution)

Native range: Endemic to western North America between the Pacific Ocean and the Rocky Mountains. Occurs from British Columbia in the north, central California in the south, and Utah in the east.

Known introduced range: USA: many states. Europe: Austria, Belgium, Czech Republic, Denmark, England, Finland, France, Germany, Hungary, Italy, Kaliningrad (Russia), Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Scotland, Spain, Sweden, Switzerland and Wales (Holdich, 2002; Machino & Holdich, 2005; and unpublished information). Japan: Hokkaido (Hiruta, 1996; Kawai & Hirata, 1999), and Honshu (Hiruta, S., 2005, pers. comm.).

Invasion pathways to new locations

Aquaculture: *P. leniusculus* was first introduced into Japan from North America for use as food in 1928 (Kawai et al. 2002b).

Natural dispersal (local): It can disperse along watercourses through natural colonization.

Management information: There are no documented control agents for the successful management of *P. leniusculus* available at this time (Holdich et al. 1999). Trapping is size selective and the smaller individuals remaining take advantage of the lack of competition to grow rapidly (Sibley, 2000). Preventing the further introduction of this species into new bodies of water is one of the few options available. Educating the public to the environmental risks this species pose and identifying new populations are key

elements to stopping the spread of this species where it is not wanted. Stebbing et al. (2003, 2004) have researched into the possibilities of using pheromones to attract male *P. leniusculus* into traps. Stringent legislation has been applied to *P. leniusculus* in Britain, which effectively makes it a 'pest' and bans the keeping of it in Scotland and Wales and much of England (Holdich et al. 2004). Despite this *P. leniusculus* continues to spread and may well cause the extinction of the single indigenous crayfish species within 30 years (Hiley, 2003; Sibley, 2003). Work is in progress in the UK to assess the use of natural pyrethrum against nuisance populations of *P. leniusculus* in enclosed water bodies (Peay, 2005).

Literature Cited:

Rusty crayfish (*Orconectes rusticus*)



Description: *O. rusticus* can be identified by its more robust claws and by the dark, rusty spots on each side of their carapace. The spots may not always be present or well developed on rusty crayfish from some waters. In the spring, males will molt into a sexually inactive form (called Form II) and then molt back into the reproductively competent form (Form I) in summer. Form I males are characterized by large claws, a hook on one pair of their legs, and hardened gonopods. The hook and the larger claws are used for grasping females during mating. Males are usually larger than females of the same age.

Ecology: According to Bowen (2003), "*O. rusticus* feed on a variety of aquatic plants, benthic invertebrates (like aquatic worms, snails, leeches, clams, aquatic insects, and crustaceans like side-swimmers and waterfleas), detritus (decaying plants and animals including associated bacteria and fungi), fish eggs, and small fish." *O. rusticus* grow larger, hide less from predators, and attain higher population densities. Therefore they need to feed more. *O. rusticus*, especially juveniles, feed heavily on benthic invertebrates like mayflies, stoneflies, midges, and side-swimmers. It has been estimated that rusty crayfish might consume twice as much food as similar-sized *O. virilis* because of their higher metabolic rate.

According to Bowen (2003), "mature *O. rusticus* mate in late summer, early fall, or early spring. The male transfers sperm to the female, which she then stores until her eggs are

ready to fertilize, typically in the spring (late April or May) as water temperatures begin to increase. The stored sperm are released as eggs are expelled and external fertilization occurs. The eggs are then attached to the swimmerets on the underside of the crayfish's abdomen ("tail section"). Just prior to egg laying, white patches appear on the underside of the abdomen ("tail section"), especially on the tail fan. These white patches are glair, a mucus-like substance secreted during egg fertilization and attachment. *O. rusticus* females lay from 80 to 575 eggs. It is important to note that it is not necessary to have both a male and a female crayfish to begin a new infestation. One female carrying viable sperm could begin a new population if released into a suitable environment. Rusty crayfish readily mate in captivity so it is reasonable to expect that mature females, whether used as fishing bait or as science class study specimens, could produce offspring."

According to Bowen (2003), "eggs hatch in three to six weeks, depending on water temperature. Once hatched, young crayfish cling to the female's swimmerets for three to four molts (molting is when crayfish shed their old shell to allow growth). Young crayfish may stay with the female for several weeks. She offers them protection during this vulnerable life stage. Eventually, the young leave the female. They undergo eight to ten molts before they mature, which may occur during the first year, but more likely the following year. Rusty crayfish reach maturity at a total length of one and three-eighths inches and reach a maximum length of about four inches (not including claws). A typical rusty crayfish lives three to four years." A mature adult male molts twice a year and a female molts once hence why males of the same age are usually larger.

According to Bowen (2003), "*O. rusticus* inhabit lakes, ponds, and streams. They prefer areas that offer rocks, logs, or other debris as cover. Bottom types may be clay, silt, sand, gravel, or rock. Rusty crayfish inhabit both pools and fast water areas of streams. They generally do not dig burrows other than small pockets under rocks and other debris, although there have been reports of more substantial burrows. *O. rusticus* need permanent lakes or streams that provide suitable water quality year-round."

According to Bowen (2003), "invading *O. rusticus* frequently displace native crayfish, reduce the amount and kinds of aquatic plants and invertebrates, and reduce some fish populations. *O. rusticus* is an aggressive species", according to Munjal and Capelli (1982, in Bowen, 2003), "that often displace native or existing crayfish species." According to Bowen (2003), *O. rusticus* displaces native crayfish by crayfish-to-crayfish competition and increased fish predation. The reason for increased fish predation on native crayfish is because *O. rusticus* force the native species from the best daytime hiding places and native crayfish try to swim away from a fish attack instead of taking the more effective claws-up defensive posture the *O. rusticus* does. Perhaps the most serious impact is the destruction of aquatic plant beds that *O. rusticus* causes. *O. rusticus* have been shown to reduce aquatic plant abundance and species diversity which can be especially damaging in areas that are relatively unproductive. These aquatic plants are important for habitat for invertebrates, food for fish and ducks, shelter for young game fish, pinfish, or forage species of fish, nesting substrate for fish, and erosion control (by minimizing waves). Although other crayfish eat aquatic plants, *O. rusticus* eat even more because they have a

higher metabolic rate and appetite. *O. rusticus*, especially juveniles, feed heavily on benthic invertebrates like mayflies, stoneflies, midges, and side-swimmers. So, they are more likely to compete with juvenile game fish and forage species for benthic invertebrates than are native crayfish species. Crayfish are eaten by fish, but because of their thick exoskeleton (shell) relative to soft tissue, their food quality is not as high as many of the invertebrates that they replace. Finally, it has been suggested that rusty crayfish harm fish populations by eating fish eggs. While rusty crayfish have been observed to consume fish eggs under various circumstances according to Horns and Magnuson, (1981, in Bowen, 2003), there is no scientific study directly linking fishery declines with crayfish egg predation. It's likely that those fish species that lay eggs in relatively warm water (greater than 50° F) are more susceptible to crayfish predation than fish that spawn during colder water periods. No detailed research has been done that proves rusty crayfish cause declines in fish populations.

Distribution: (Figure 2, North American distribution.)

Native range: Indiana, Ohio, Kentucky, and Michigan in the United States.

Known introduced range: Has invaded many areas surrounding its native range. It has moved as far west as North and South Dakota, north as Canada and Maine, and south as Tennessee. *O. rusticus* is currently not found in Utah.

Invasion pathways to new locations: Anglers using crayfish as bait are thought to be the primary cause of introduction. Developing a viable commercial harvest of *O. rusticus* from natural lakes could be incentive for trappers to plant them in other waters (Bowen, 2003). According to Bowen (2003), *O. rusticus* are sold to schools by biological supply houses. Even though a warning not to release *O. rusticus* into the wild accompanies crayfish sold to schools, such warnings may be forgotten, or live crayfish may be given away to students and they may eventually be released into the wild.

Management information: Some researchers have suggested that nuisance populations of rusty crayfish are the result of poor fishery management and that by restoring a healthy population of bass and sunfish, *O. rusticus* would be less disruptive in some lakes. The best method of control is to prevent their introduction. Educating anglers, crayfish trappers, bait dealers, and teachers about the threats posed by *O. rusticus* will help reduce the risk of spreading *O. rusticus* to new areas. According to Bowen (2003), “environmentally-sound ways to eradicate or control introduced populations of *O. rusticus* have not been developed, and none are likely in the near future. The best way to prevent further ecological problems is to prevent or slow their spread into new waters. Regulations in both Minnesota and Wisconsin now make it illegal to introduce *O. rusticus* into any waters. In Minnesota, it is illegal to sell live crayfish as bait and a Department of Natural Resources permit is required to commercially harvest or culture crayfish. Intensive harvest will not eradicate or control crayfish, but may help reduce adult populations and minimize some impacts.”

Many chemicals kill crayfish. Some even selectively kill crayfish; however, none are currently registered for crayfish control according to Bills and Marking (1988 in Bowen, 2003). And, none selectively kill *O. rusticus* without killing other crayfish species.

Literature Cited:

Quagga mussel (*Dreissena bugensis*) (N.Muth)

Ecology: The quagga mussel is a cousin of the zebra mussel and portrays many of the same characteristics. It is a freshwater, bivalve mollusk that can grow slightly larger than the zebra mussel; up to four centimeters larger. The quagga mussel has a rounded angle, or carina, between the ventral and dorsal surfaces (May and Marsden 1992). The quagga also has a convex ventral side that can sometimes be distinguished by placing cells on their ventral side; a quagga mussel will topple over, whereas a zebra mussel will not (Claudi and Mackie 1994). Color patterns vary widely with black, cream, or white bands. They usually have dark concentric rings on the shell and ventral side and are paler in color near the hinge.

Quagga mussels are filter feeders, removing substantial amounts of phytoplankton and suspended particulate from the water. Impacts on aquatic resources from this filtering are similar to those of zebra mussels. Quagga mussels remove phytoplankton from the water causing alterations in the food web. Impacts associated with the filtration of water include increases in water transparency, decreases in mean chlorophyll, and concentration and accumulation of pseudofeces (Claxton et al., 1998). Increased amounts of pseudofeces in the water have been associated with poor water quality, foul odor and taste. As the waste particles decompose, oxygen is used up, the pH becomes very acidic and toxic byproducts are produced. In addition, quagga and zebra mussels accumulate organic pollutants within their tissues to levels more than 300,000 times greater than concentrations in the environment. These pollutants are found in their pseudofeces, which can be passed up the food chain; therefore, increasing wildlife exposure to organic pollutants (Snyder et al., 1997).

Observations and research suggest the North American quagga mussel is a cold, deep-water form, contrasting with Ukraine populations where the quagga mussel thrives at higher temperatures. In North America, zebra mussels survive indefinitely at 30° C, but the quagga mussel exhibits high mortality at this same temperature (Mills et al., 1996). Although there are indications that quaggas die at lower temperatures than zebra mussels, there are a few exceptional quaggas that are as tolerant of elevated temperatures as zebra mussels, so the potential thermal range of this species may be higher than recent experiments indicate (Mills et al., 1996). Temperature is also a key factor affecting spawning and fertilization in dreissenid mussels. A minimum spawning temperature of 12° C has been reported for zebra mussels compared to 9° C spawning temperature for quagga mussels, which suggests the zebra mussel cannot successfully colonize hypolimnial waters. Although, they have been reported to survive in the hypolimnion, they cannot reproduce there (Claxton and Mackie, 1998). A female quagga mussel with mature gonads was found in Lake Erie at a temperature of 4.8°C, so areas that were thought to be immune to *Dreissena* colonization may become infested by quagga mussels (Claxton and Mackie, 1998).

Just like zebra mussels, quagga mussels have the capability to attach themselves to any hard surface or substrate; they will even attach on soft substrates and plants. They have the ability to clog pipes used for irrigation, municipal purposes and power generation. Quagga mussels, just like zebra mussels, can cause millions of dollars in damage to our industries. Quagga mussels have a greater tolerance for cooler water temperatures than zebra mussels, and have been found to colonize substrates at greater water depths.

Distribution: Quagga mussels are indigenous to the Dneiper River drainage of Ukraine. It was first documented in the Great Lakes in September 1989, and after confirmation that this mussel was not a variety of zebra mussel, the new species was named "quagga mussel" after the quagga mammal, an extinct African relative of the zebra. Quagga mussels are abundant in the Great Lakes region and more recently have established themselves west of the 100th meridian in the lower Colorado River drainage. In 2007, quagga mussels were confirmed in Lakes Mead, Mojave, and Havasu. Downward drift of planktonic veligers from the aforementioned reservoirs has caused the contamination of the lower Colorado River Basin, areas served by the Central Arizona Project, and areas served by the Southern California aquaduct.

Vectors of Introduction: The rapid invasion and expansion to the west has been exponential due to their ability to disperse at all different stages of life. Quagga mussels move many different ways. The first way they move is naturally, being carried passively as planktonic larvae (veligers) in flowing or wind-driven (wave) water currents and by attaching themselves to other organisms such as crayfish or turtles (Carlton 1994). They may also attach to legs, feet, and feathers of waterfowl and shore birds, but these are only low-level vectors (Johnson 1994). Quagga mussels are mostly transported by humans on their boats. Recreational boating and the ability to move boats and other equipment long distances in short periods of time opens a large introduction capability. All forms of quagga mussels can be transported in many ways including the following: ballast systems, live wells, bait wells, bilge tanks, ski storage areas, cooling systems, and basically anywhere water can be stored. Adult quagga mussels are more likely to attach themselves to boats and equipment and can survive several days out of the water. Some have been known to survive up to 27 days in the right conditions. Quagga mussel veligers are more susceptible to dying in hot, dry conditions. All human forms of introduction can be prevented if the proper precautions and decontamination procedures are followed. Outreach messages across the nation stress "clean," "drain," and "dry" all watercraft and equipment having contact with infested waters.

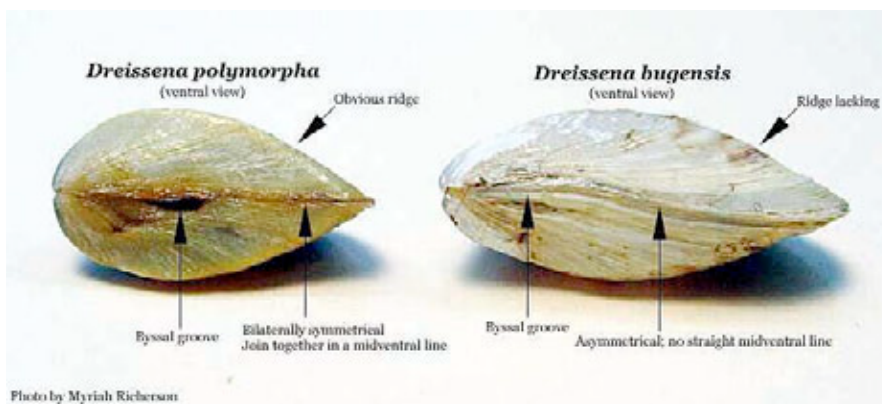
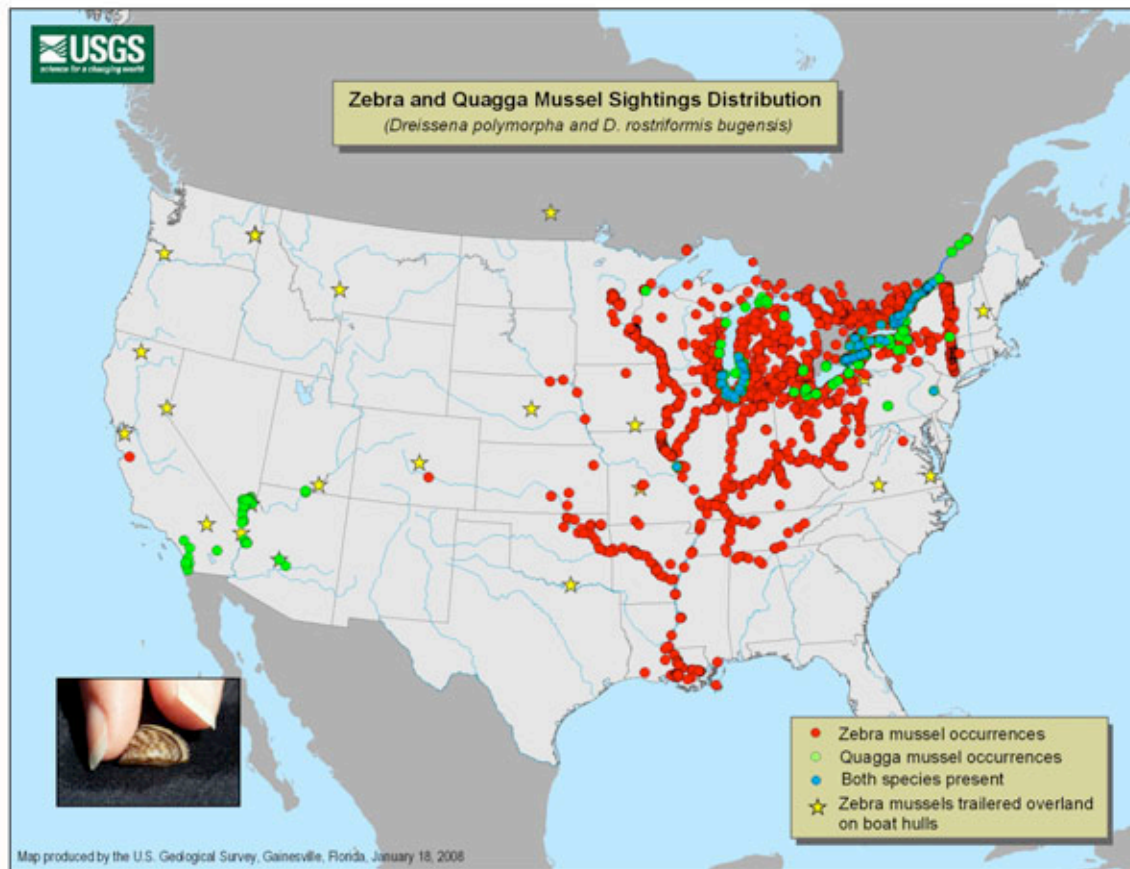
Management consideration: Many different approaches to management have been considered and executed; most resulting in limited or little success. To date, no single "silver bullet" quagga mussel control technology has been identified that will work in all water settings. However, wide arrays of alternative control methods exist for quagga mussels and are suitable or practical for most situations.

- Manual removal
 - High pressure washer

- Scalding hot water (140° F)
- Manual scraping
- Mechanical filtration
- Disposable substrates
- Molluscicides
- Chemical removal
 - Chlorination
 - Potassium permanganate
 - Metallic salts
 - Non-oxidizing biocides
 - Oxidizing biocides
 - Asphyxiation
 - Thermal treatment
 - Exposure to desiccation
 - Ultraviolet irradiation
 - Biological control
- Prevention of settling
 - High-velocity flow
 - Coatings
 - Electrified surfaces and electrostatic shock
 - Cathodic protection
 - Acoustics
 - Cavitation
- Biological
 - Predators (e.g. freshwater drum, carp, and some sunfish. Also diving-ducks, crayfish and raccoons)
 - Parasites (e.g. trematodes and annelids)



Literature Cited:



Zebra mussel (*Dreissena Polymorpha*) (N.Muth)

Ecology: Zebra mussels are small, freshwater, bivalve (having two matching halves) mollusks with elongated shells typically marked by alternating light and dark bands (zebra stripes). However, shell patterns can vary to the point of having only light or dark colored shells and no stripes. Size ranges vary from 1-5mm in their juvenile form to 15+ mm in the adult form. Zebra mussels have byssel threads that allow easy attachment to

almost anything. Their considerable genetic and morphological plasticity and broad environmental tolerances enable these organisms to live in a wide variety of habitats. They are prolific, they even attach to each other forming dense layered colonies up to one foot thick. Mussel densities of over 1 million per square meter have been recorded in parts of Lake Erie. Zebra mussels produce microscopic larvae (veligers) that float freely in the water column at numerous depths. Females generally reproduce in their second year by expelling eggs, which are fertilized outside of the body by males: this process usually occurs in the spring and summer, depending on the water temperature. Spawning begins as ambient water temperatures reach approximately 12°C and peaks as temperatures reach the 15°C to 17°C range (Claudi and Mackie 1994). Spawning may be interrupted when temperatures exceed 28°C and will resume when temperatures cool below that threshold (Nichols 1994). Spawning has occurred in the Great Lakes at temperatures as low as 10°C and the larvae have been seen throughout the winter months. Zebra mussel spawning produces planktonic veligers approximately 40µm (microns) in length that are capable of active swimming for one to two weeks. Within two to five weeks of hatching, the larval mussels become too large (200µm+) and heavy to remain planktonic, and they begin to settle out of the water column (Nichols 1994). At this point mussels, must find a hard substrate to attach themselves to. Once attached, the lifespan of a zebra mussel ranges from 3 to 9 years.

Zebra mussels are diverse, but also have some defined environmental limitations. Zebra mussels can live at water temperatures approaching freezing, but spawning stops below 10°C and can grow very slowly as temperatures continue to decline. This cold climate can reduce density potentials. Zebra mussels will die when the water temperature falls to levels that would cause ice to form within their bodies. On the opposite end of the temperature spectrum, lethal high temperatures are reached at between 31°C and 35°C.

Because zebra mussels need a good deal of calcium to form their shells, requiring water containing more calcium, generally 25 parts per million or greater. Potential for spawning is very low below 9 parts per million of calcium. Zebra mussels thrive in waters that are neither too acidic nor too alkaline, generally pH levels between 7.5 and 8.7. Very low potential exists about 9.0 and below 7.2. The threshold for survival of adults is 6.5 (McCauley and Kott 1993) and for larvae, 6.9 (Mackie and Kilgour 1993). Zebra mussels also require relatively high oxygen concentrations. Little if any colonization will occur at dissolved oxygen concentrations less than 40 to 50 percent full air saturation (McMahon 1995). Velocity of water currents is optimal at 0.09 to 1.0 meters per second. Colonization potential does not become low until velocities either exceed 1.5 meters per second or drop below 0.075 meters per second (O'Neill 1995). Salinity is also a limiting factor in the growth and survival of zebra mussels. Zebra mussels can inhabit brackish areas ranging from 0.2 to as high as 12.0 parts per thousand total salinity (MacNeill 1990).

Zebra mussels adhere to most any surface, including other living organisms in a lake's ecosystem (e.g. native mussels, crayfish and turtles) Zebra mussels seek out hard surfaces such as: rocks, concrete, steel, pilings, metal grates, boat motors, boat hulls, docks, anchor lines, buoy lines etc. Zebra mussels exhibit some limitations when colonizing

which include extensive siltation, microalga, fluctuating water levels, and antifouling covered surfaces.

Monitoring and control of zebra mussels costs millions of dollars annually and could cost Utah upwards of 15 million dollars a year in maintenance costs (Suflita 2007). Zebra mussels have the biofouling capabilities of colonizing water supply pipes and reducing water flow, inhabiting hydroelectric power plant, disrupting public water supply plants and drastically increasing the maintenance costs at industrial facilities. They are a threat to more than just the world of recreational water use, they are a threat to every person who turns on that tap to get a glass of water, every farmer who uses irrigation pipes or canals where the water is coming from a reservoir, They are a threat to us all here in the west.

Zebra mussels have negative impacts on aquatic ecosystems, reeking havoc on native organisms and native fish populations. Zebra mussels are filter feeders consuming phytoplankton and zooplankton from the water column. Zebra mussels are efficient and can filter up to 1 liter of water per day per individual. They have the capability of filtering an entire lakes volume in a matter of days; it is reported that they filter the entire volume of Lake Erie in 36 hours. This leads to an increase in water clarity and greater penetration of sunlight, allowing development of unwanted macrophytes. The filtering of plankton, which is microscopic, allows the smallest and most basic part of the food chain to be broken, having devastating effects on life cycles of plants, animals, and fish. Zebra mussels can also pollute the water by releasing pseudofeces back into the environment affecting other trophic levels. There are known predators of the zebra mussels such as native birds and some non-native fish, e.g. round goby (*Neogobius melanostomus*), and while the mussel food source may benefit such predators, biomagnifications of toxins into both fish and birds is a potential risk. Loon die offs in recent years on the Great Lakes is strongly suspicioned to be associated with biomagnification of pollutants due to the loons eating Dreissena mussels.

Distribution: Zebra mussels are native to the Black, Caspian and Azov seas. They were first introduced into North America by transoceanic ships entering the Great Lakes system around the mid 1980's, ultimately being discovered in the United States in 1988 in Lake St. Clair. Since this date they have spread throughout the Great Lakes region, along their major tributary and effluent rivers, and they crossed the 100th meridian invading the west in 2007. By late 2007 zebra mussels were known from Pueblo Reservoir in south-central Colorado and San Justo Reservoir in west-central California. They have been interdicted alive on tailored boats, which is the most common method of transportation, in California, Washington, and British Columbia.

Vectors of Introduction: The rapid invasion and expansion to the west has been exponential due ability to disperse at all different stages of life. Zebra mussels move many different ways, the first way is naturally, being carried passively as planktonic larvae (veligers) in flowing or wind-driven (wave) water currents and by attaching themselves to other organisms such as crayfish and turtles (Carlton 1994) They may also attach to legs, feet, and feathers of waterfowl and shore birds, but these are only low-level

vectors (Johnson 1994). Zebra mussels are mostly transported by humans on their boats. Recreational boating and the ability to move boats and other equipment long distances in short periods of time opens a large introduction capability. All forms of zebra mussels can be transported in many ways including the following: ballast systems, live wells, bait wells, bilge areas, ski storage areas, cooling systems and basically anywhere water can be stored on a boat. Adult zebra mussels are more likely to attach themselves to boats and equipment and can survive several days out of the water. Some have been known to survive up to 27 days in the right conditions. Zebra mussel veligers are more susceptible to dying in hot, dry conditions. All human forms of introduction can be prevented if the proper precautions and decontamination procedures are followed. Outreach messages across the nation stress “clean,” “drain,” and “dry” all watercraft and equipment having contact with infested waters.

Management consideration: Many different approaches to management have been considered and executed, most resulting in limited or little success. To date, no single “silver bullet” zebra mussel control technology has been identified that will work in all water settings. However, a wide array of alternative control methods exists for zebra mussels, and many are suitable or practical for most situations.

- Manual removal
 - High pressure washer
 - Scalding hot water 140° F
 - Manual scraping
 - Mechanical filtration
 - Disposable substrates
- Chemical removal
 - Metallic salts
 - Nonoxidizing biocides
 - Oxidizing biocides
 - Asphyxiation
 - Thermal treatment
 - Exposure to desiccation
 - Ultraviolet irradiation
 - Biological control
- Prevention of settling
 - High-velocity flow
 - Coatings
 - Electrified surfaces and electrostatic shock
 - Cathodic protection
 - Acoustics
 - Cavitation
- Biological
 - Predators (e.g. birds and non-native fish)
 - Parasites (e.g. trematodes and annelids)

Zebra Mussels



Literature Cited:

Conrad's False Mussel ([N.Muth](#))

Vertebrates

Reference Utah Comprehensive Wildlife Conservation Strategy (Wildlife Action Plan) noting that non-native fish species compete with either Tier I (T&E), Tier II (species of onservation concern) or Tier III (species with at-risk habitats) native species and cite (1) Utah Wildlife Code, (2) Collection, Importation & Possession of Zoological Animals and (3) Collection, Importation & Possession of Amphibians & Reptiles as authorities. ([intro L.Dalton](#))

Fish

Mosquito Fish ([J.Polloczek](#))

Burbot (*Lota lota*) ([N.Muth](#))

Ecology: Burbot are large fish known to grow to as much as 1.5 meters in length and 34 kilograms in mass (Morrow 1980). These fish are yellow, light tan, or brown with dark brown or black patterning on the body, head, and most fins. The underbelly and pectoral fins are pale to white (Cohen et al. 1990; Morrow 1980). The first dorsal fin is short and is followed by a long second dorsal fin at least six times the length of the first and joined to a rounded caudal fin (Morrow 1980). Burbot have neither dorsal nor anal spines and have 67 to 96 soft dorsal rays, and 58 to 79 soft anal rays (Cohen et al. 1990). Gill rakers are short, pectoral fins are rounded, and caudal fins have 40 rays (Morrow 1980). Like other cods, burbot are also characterized by a single barbel located on the chin ([Cohen et al., 1990; Morrow, 1980](#)). Newly hatched burbot are completely planktivorous, and remain so even when they are no longer gape limited (Ghan and Sprules 1993). Diet of larval burbot is dominated by rotifer species for the first two weeks. Diet then shifts to slightly larger nauplii, changing further during week four to cycloid copepods, daphnia, and calanoid copepods (Ghan and Sprules 1993). Juveniles have a diet of molluscs and insect larvae (Tolanen et al. 1999). Adult burbot are piscivorous and consume over 99% fish by mass in Lake Superior (Bailey 1972). Though burbot are always a primarily piscivorous fish, their diet changes seasonally and in response to competition. After the winter months, Tolanen et al. (1999) found that burbot ate a much higher proportion of aquatic invertebrates, namely crustaceans in the early summer and oppossum shrimp in the fall. In the Vilyusk resevoir, their diet overlaps with pike and forces burbot to broaden

their diet breadth to include more benthic invertebrates (Kirillov 1988). In addition to fish and invertebrates, Bailey (1972) also found rocks, wood chips, plastic, and other inert materials in burbot stomachs, indicating that burbot feeding habits were somewhat indiscriminate (Bailey, 1972; Ghan and Sprules, 1993; Kirillov, 1988; Tolanen, Kjellmann, and Lappalainen, 1999). Burbot are top predators in their ecosystem, sometimes overlapping with similar top predators such as pike or large salmonids (Kirillov 1988).

Habitat: Burbot are demersal fish found in deep temperate lake bottoms and slow moving cold river bottoms between four and eighteen degrees C (Riede 2004; Cohen et al. 1990). Primarily found at depths ranging from 1 to 700 meters, these fish prefer fresh waters, but are also found in some brackish water systems (Cohen et al. 1990). These fish often dwell among benthic refugia such as roots, trees, rocks, and dense vegetation (Billard 1997). (Billard, 1997; Cohen et al., 1990; Morrow, 1980; Riede, 2004; Scott and Crossman, 1973).

Reproduction & Development: Burbot eggs hatch in the spring between April and June, depending on location (Bjorn 1940; Cohen 1990). Time until hatching is dependent on temperature as well as the particular population and eggs usually take between 30 and 70 days to hatch (MacCrimmon 1959; Bjorn 1940). In four weeks larval burbot increase in length from less than one centimeter to over two centimeter (Ghan and Sprules 1993). Burbot in Lake Superior exhibited very fast growth rates during the first two growing seasons, attaining 42% of total length after ten growing seasons (Bailey 1972). (Bailey, 1972; Bjorn, 1940; Cohen et al., 1990; Ghan and Sprules, 1993; MacCrimmon, 1959). In the Vilyuy River Basin, Siberia, burbot attain sexual maturity in their 7th or 8th year, with males usually maturing one year before females (Kirillov 1988). In Lake Superior, burbot as young as one year old were sexually mature (Bailey 1972). Though sexually mature specimens were found for both sexes in year one and older age classes, there was a higher proportion of sexually mature males until year five when all specimens of both sexes were sexually mature (Bailey 1972). Activity of burbot increases in autumn as energy reserves are concentrated on the growth and development of gonads for the winter spawning season (Kirillov 1988). Maturation of the gonads in both sexes occurs at about four months after the fall peak in nutritional reserves (Pulliainen and Korhonen 1990). (Bailey, 1972; Kirillov, 1988; Pulliainen and Korhonen, 1990).

Burbot breed once per year in the winter, migrating to shallow water or to a smaller stream to spawn (Cohen 1990). Burbot move to spawning areas individually and males tend to arrive before females (Morrow 1980). Spawning occurs during the night when individuals form a globular mass, each fish pushing toward the center and releasing eggs or sperm (MacCrimmon 1959; Cahn 1936). Postspawning runs upstream have been observed, most likely for feeding (Cahn, 1936; Cohen et al., 1990; MacCrimmon, 1959; Morrow, 1980). Burbot are broadcast spawners and provide no parental care. Parental investment in burbot is characterized by an increased metabolic activity level and food consumption rates in the fall in order to contribute to the growth and maturation of gonads in both male and females over a four month period preceeding spawning events (Pulliainen and Kohonen 1990; Kirillov 1988). It has been suggested that burbot may

require one to two years to replenish their nutritional reserves after each spawning event, but no further information on this topic was available. (Kirillov, 1988; Pulliainen and Korhonen, 1990).

Management Considerations: Burbot are a non-native invasive species probably introduced by sportsman into Flaming Gorge Reservoir. Burbot have been found as far south into Utah as Linwood Bay and Antelope Flat. Biologists expect the burbot to move into the canyons and as far south as the Flaming Gorge Dam. The only management tactic that has been tried on the lake, so far, is angling. Burbot have no limit and have a must kill or illegal to release law. Burbot have been caught over the winter months through the ice in large quantities. Because this is a newly introduced species into Flaming Gorge Reservoir, DWR, in cooperation with Utah State University, will begin a graduate study in 2008.

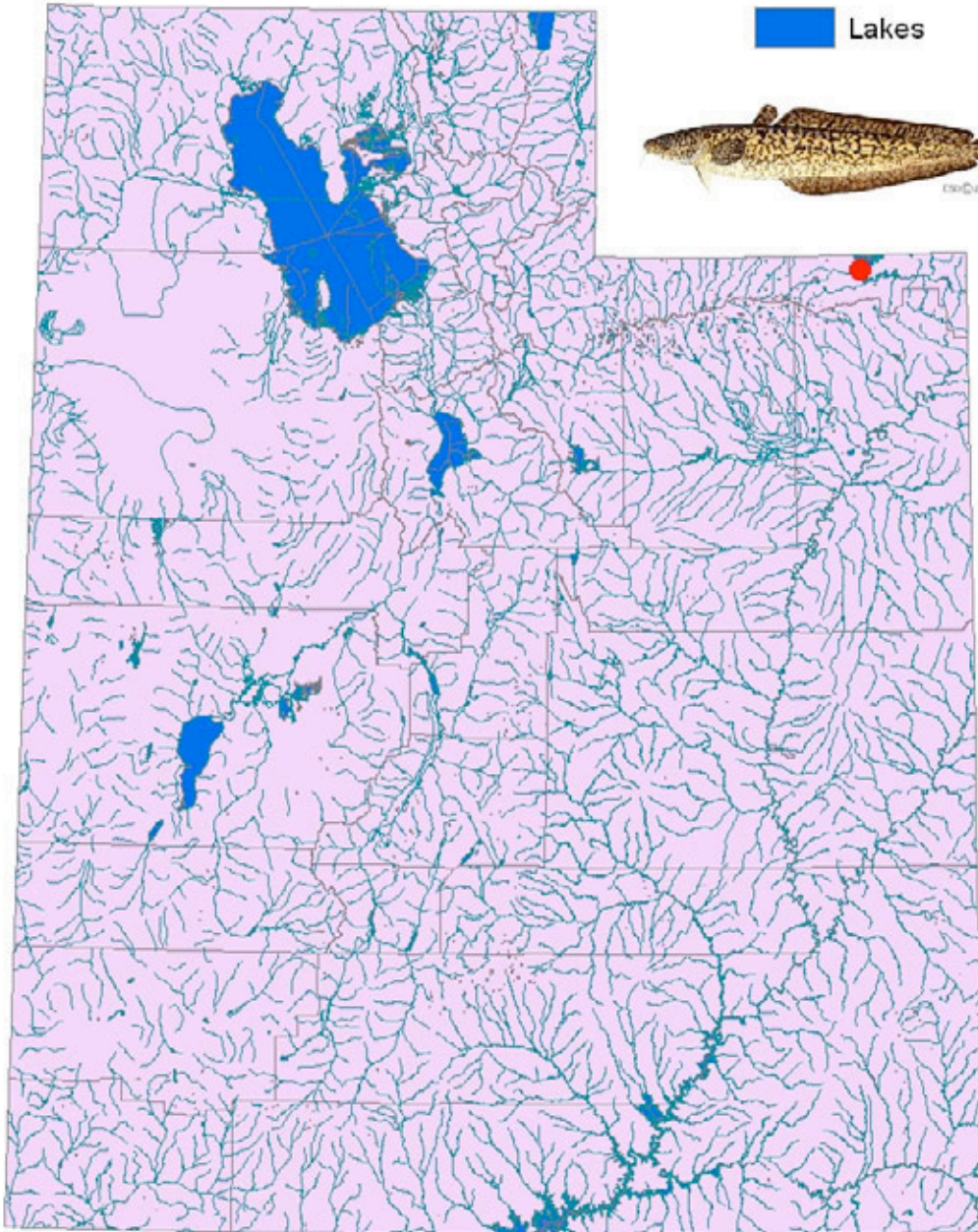
Burbot

Lota lota

Legend

— Streams

■ Lakes



Gizzard shad (*Dorosoma cepedianum*) (D.Keller)



Coloration: Back silvery blue, somewhat iridescent; sides silvery above, whitish below; abdomen white. Fins darkened. Dark purplish spot about the size of the eye present immediately behind the upper end of the gill opening in y-o-y. Spot becomes obsolete and disappears with age.

Mouth: small subterminal, slightly overhung by the rounded snout. Centrally notched upper jaw protrudes slightly beyond lower jaw. Maxillary reaching below the anterior margin of the eye. Gill rakers long, slender.

Body: Deep strongly compressed laterally. Average TL 225-350 mm. Scales large, cycloid, deciduous. Lateral line lacking. Median lateral series of scales 61 (52-70). Ridge of sawlike ventral scutes on abdomen.

Ecology: The gizzard shad is common in lakes, oxbows, impoundments, sloughs and large rivers with basic or low gradients (Trautman 1981; Etnier and Starnes 1993), but reaches greatest abundance in waters where fertility and productivity are high (Robison and Buchanan 1988; Pflieger 1997). Gizzard shad avoid high gradient streams and rivers in the mountains and rivers without large, permanent pools, but can tolerate moderately turbid and occasionally even brackish or salt waters (Trautman 1981; Robison and Buchanan 1988; Pflieger 1997). The gizzard shad prefers living in open water, at or near the surface (Becker 1983; Harlan et al. 1987).

The gizzard shad spawns in shallow backwaters or near the shore. Gizzard shad spawn at night, spring to summer, eggs hatch in about 2-4 days. Eggs randomly scatter and adhere to plants, rocks or firm substrate. Spawning may occur when water warms to the high 50's but the peak happens from 66-72 F (19-22 C) during a 6-week spawning period. Fecundity ranges from 22,000 to 350,000. Most spawn at age II during a six-week spawning period. Buoyant larvae become plankton. They reach sexual maturity usually in 2-3 years (Robison and Buchanan 1988). Life span is generally about 4-6 years; few survive beyond age III (Sublette et al. 1990). Typically found traveling in schools, juveniles are nonvisual planktivores, most commonly utilizing zooplankton and phytoplankton in the diet. Adults are primarily bottom filter-feeding detritivores; which typically eat large quantities of organisms attached to underwater surfaces, especially

from littoral areas. Gizzard shad also feed on phytoplankton in open water (Sublette et al. 1990).

The gizzard shad feeds by swimming through the water with its mouth open in an apparently aimless manner. Numerous fine gill rakers are present in the gills and act like a very fine sieve; water passes out through the gill slits as the fish swims along, while tiny organism are retained and introduced into its alimentary canal.

Distribution: Gizzard shad were unknown in Utah until 2002 when six individuals were documented in the San Juan arm. They are currently found all over Lake Powell. Since the initial discovery in 2002 Gizzard shad have spread into the Colorado River and Green River systems (fig.1)

In 2006 sampling of the Green River was conducted to evaluate a response of small-bodied native fish to nonnative predator removal. Seining was conducted in suitable low-flow and backwater habitats. Of potential significance in 2006 were the observation of small gizzard shad in backwaters, a decrease in the number of native species, and the number of individuals within each native species. Not all gizzard shad were measured; however, of those that were (n=8), their mean length was 39.75 mm. Lengths of these fish ranged from 36mm to 41mm. Given that fish of such small lengths were found in several backwaters from river mile 281 to 215 (nine total backwaters), the researchers suggested that this species has begun to reproduce in the middle Green River.

Pathways of introduction: It is unknown exactly how gizzard shad were introduced into Utah. It is likely that they came from illegal fish stocking by individuals under the assumption that they would provide good forage for Lake Powell sport fish. Also, they may have been accidentally introduced via fish transport operations from other states in which they are common. It has been reported by U.S. Fish and Wildlife Service that gizzard shad were accidentally introduced into Morgan Lake near Shiprock, NM with a shipment of largemouth bass in 1998. The bass came from Inks Dam National Fish Hatchery in south-central Texas in the Rio Colorado drainage where gizzard shad are abundant in the surface water used at the hatchery. Later loads of bass transported to Morgan Lake from the hatchery were found to have as many as 9 different species besides largemouth bass (fish species included Guadalupe bass, logperch, gizzard shad, white bass, bluegill, and dollar sunfish).

Management considerations: A review by DeVries and Stein (1990) suggests that gizzard shad might not be ideal forage fishes. Gizzard shad can consistently produce large numbers of offspring from few adults (Miller 1960; Pierce 1977), and their larvae may compete with other fishes for zooplankton (DeVries and Stein 1992). Furthermore, because gizzard shad grow quickly (Bodola 1966), they often reach a size refuge from most predators by the end of their first year (Adams and DeAngelis 1987; Johnson et al. 1988). Impressive larval production coupled with fast growth limits predator consumption to a maximum of 30% of gizzard shad production in Ohio reservoirs (Johnson et al. 1988). Most importantly, however, gizzard shad are opportunistic omnivores, feeding on zooplankton as larvae, but capable of switching to phytoplankton or detritus as juveniles and adults (Miller 1960; Bodola 1966; Pierce et al. 1981). As a

result, gizzard shad can drive zooplankton to extinction, yet still survive and grow to adulthood. Gizzard shad also spawn before many sport fishes (e.g., bluegill *Lepomis macrochirus*), thus their larvae may deplete zooplankton resources to the extent that sport-fish larvae may face unfavorable conditions for growth and survival.

In 2006 Lake Powell threadfin shad populations decreased as a response to heavy predation from large numbers of adult sport fish, the adult gizzard shad population continued to grow. Due to the suitable habitat available and implications of gizzard shad in Lake Powell, this species will affect the management and planning of recreational sport fishing opportunities of nonnative fish in Glen Canyon NRA. The competitive nature of gizzard shad may pose a threat to endangered species of the Colorado River.

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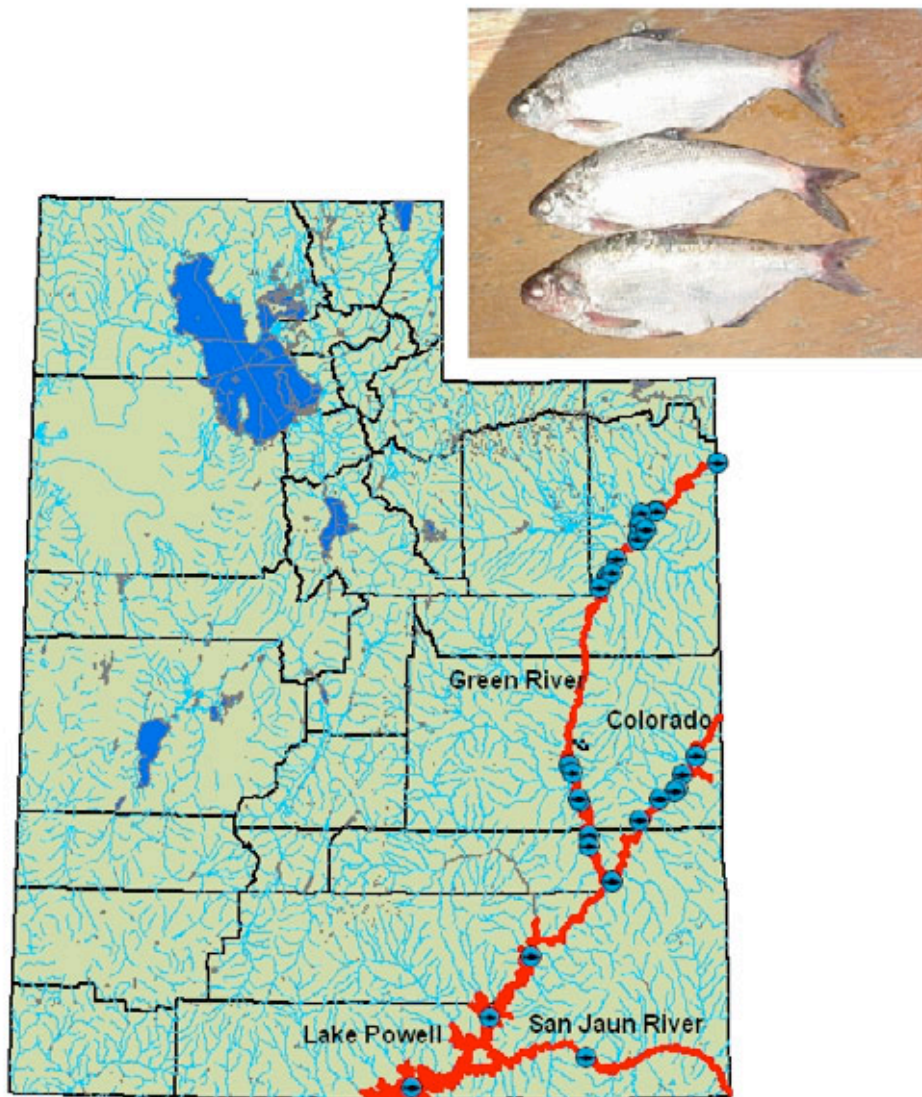
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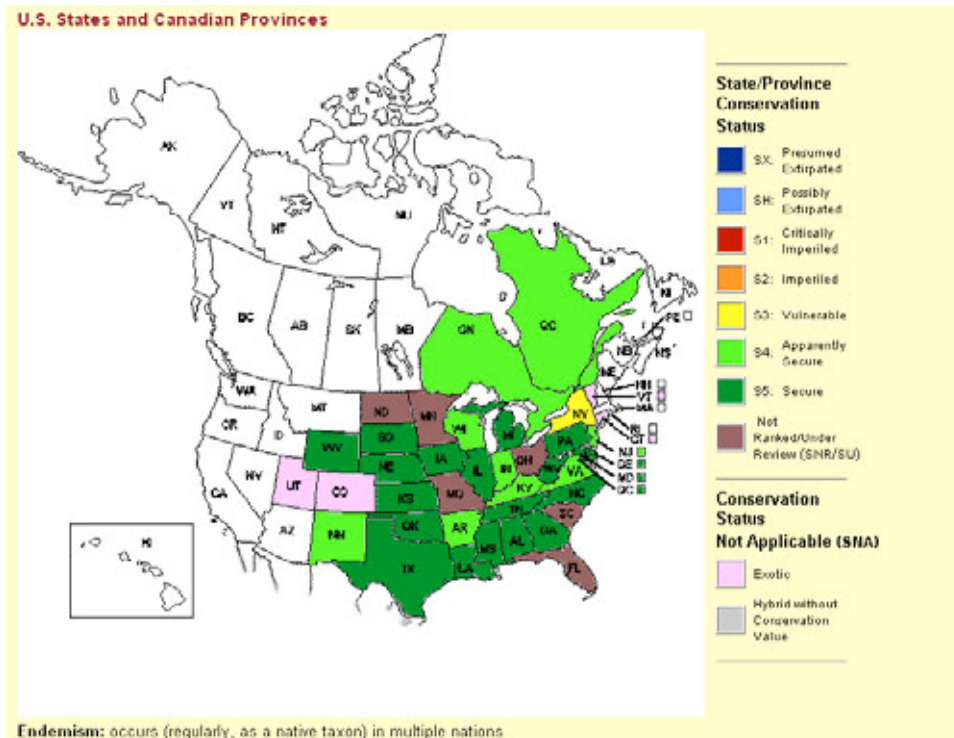
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**Fig 1. Gizzard Shad (*Dorosoma cepedianum*)
Documented and probable distribution.**

- Sites where Gizzard Shad have been sampled
- Probable Range



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Amphibians

North American Bullfrog (*Rana catesbeiana*) (N.Muth)

Ecology: North American bullfrogs are the largest true frog found in North America, weighing up to 0.5 kg and 203 mm in length. Typical length ranges from 90 to 152 mm. Color varies from brownish to shades of green, often with spots or blotches of a darker color about the back. The hind feet are fully webbed. The sex of an adult bullfrog can be easily determined by examining the size of the tympanum (the external ear of the frog) relative to that of the eye. The tympanum is a round circle located on the side of the head near the eye, and in males it is much larger than the eye. In females the tympanum is as large or smaller than the eye. Also, during the breeding season the throat of the male bullfrog is yellow, whereas the female's is white. Bullfrogs are normally found in the Eastern US & Canada. They were introduced into California and Colorado in the early 1900's and since then bullfrogs have been introduced in Southern Europe, South America and Asia.

Reproduction: Breeding takes place in May to July in the north, and from February to October in the south. Fertilization is external, with the females depositing as many as 20,000 eggs in a foamy film in quiet, protected waters. Fertilization is usually, but not always, by one male. Tadpoles emerge about four days after fertilization. These tadpoles may remain in the tadpole stage for almost 3 years before transforming into frogs. Adults reach sexual maturity after 3 to 5 years. The average bullfrog lives seven to nine years in the wild. The record lifespan of an animal in captivity is 16 years.

Habitat: North American bullfrogs prefer warm weather and will hibernate during cold weather. A bullfrog may bury itself in mud and construct a small cave-like structure for the winter. Their hunting style is 'sit and wait.' Bullfrogs can wait for a long time for some type of prey to come by, then, pounce on their prey and eat it. Bullfrogs are active both during the day and at night; they are most active when the weather is moist and warm.

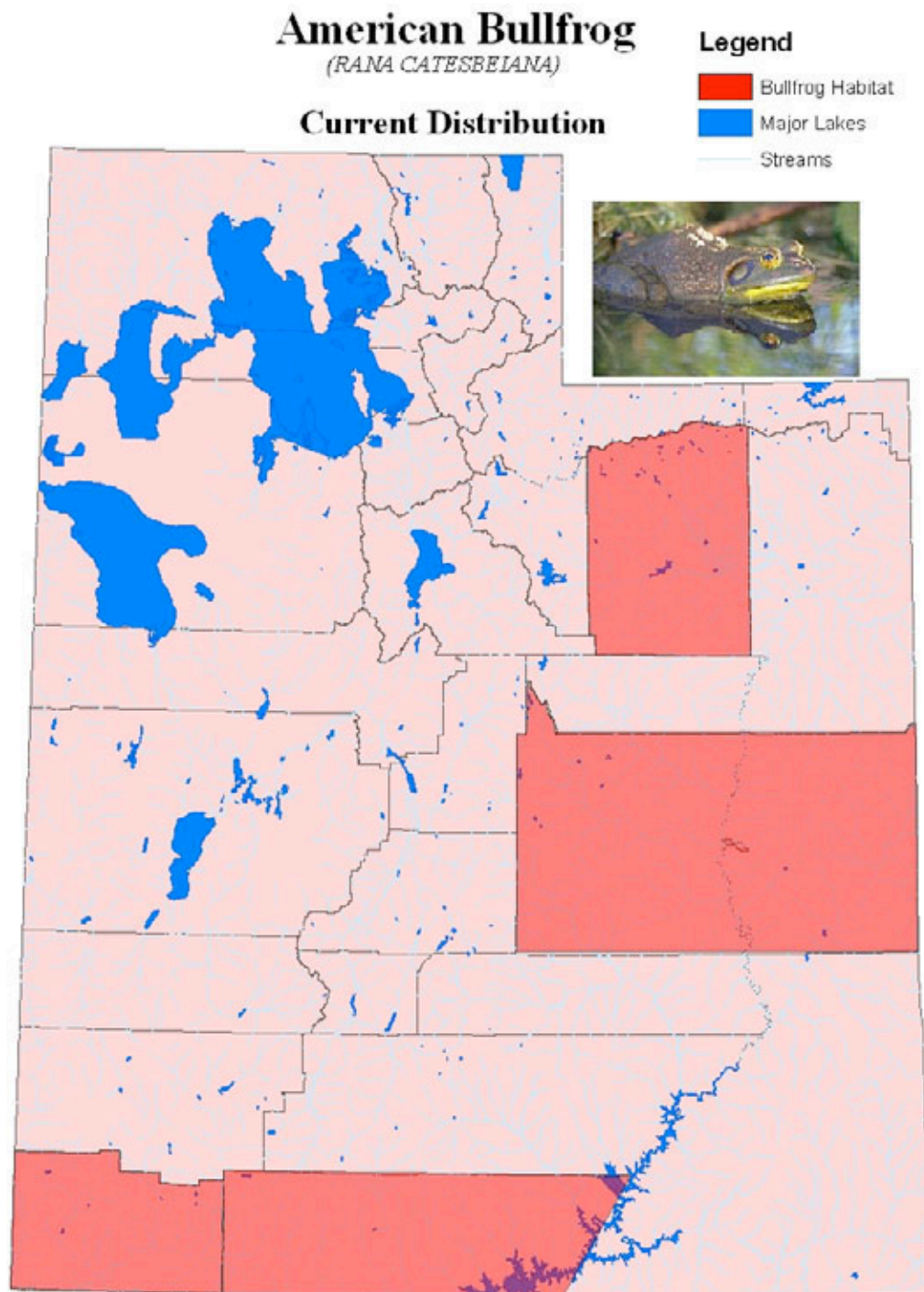
Food Habits: Bullfrogs are very aggressive predators. They usually eat [snakes](#), [worms](#), [insects](#), mice, [crustaceans](#), [frogs](#), tadpoles, and aquatic eggs of [fish](#), frogs, insects, or [salamanders](#). They are cannibalistic and will not hesitate to eat their own kind. There have also been a few cases reported of bullfrogs eating bats, and turtles. A good "rule of thumb" for bullfrogs is that if it will fit in their mouths, they will eat it. Bullfrog tadpoles mostly graze on aquatic plants.

Predation: Humans hunt bullfrogs for frog legs, but they have a limited hunting season in most states. Bullfrogs are also eaten by a wide variety of other animals, depending on the region. These include [herons](#), such as [great blue herons](#) and [great egrets](#), [turtles](#), [water snakes](#), [raccoons](#), and [belted kingfishers](#). Most fish are averse to eating bullfrog tadpoles because of their undesirable taste. In southern states large mouth bass are their main fish predators.

Management Strategies: Strategies to control negative impacts from bullfrogs vary from state to state. In California, where predation by bullfrogs on red-legged frogs has been

documented, the recommended technique for cattle ponds is draining them entirely while at the same time shooting adults as they attempt to escape (Doubledee et al. 2003). Arizona has employed this technique in numerous isolated areas around the state to benefit various sport fisheries. Colorado allows unlimited statewide harvest of bullfrogs, which can legally be taken by archery, gig, dip net, or by hand. Members of the public still continue to move bullfrogs around in British Columbia, so they have implemented an extensive public education program to increase people's knowledge of the harm that bullfrogs do to native ecosystems. Govindarajulu (2004), after reviewing the situation in British Columbia, concludes that complete eradication is only feasible in small, isolated areas. He does, however, recommend culling metamorphs in the early fall as a method to control their populations (Govindarajulu et al. 2005) vs. removal of adults, which tends to increase populations due to decreased cannibalism. In Utah, along the Wasatch Front, nurseries were giving away bullfrogs with the purchase of backyard water features. Teachers were also receiving bullfrog tadpoles in educational activity kits and then allowing children to take the frogs home when the lesson was completed. In response to these sorts of activities, biologists with the Utah Division of Wildlife worked with nurseries to discontinue giving away bullfrogs. Bullfrogs have been a prohibited species in Utah for quite awhile so it was not difficult to get them to discontinue this activity once they realized it was illegal. Members of the Division also contacted the companies distributing frogs with the educational kits. Educators in Utah will no longer receive bullfrogs if they order from these companies; however, educators in neighboring states can still receive frogs with their order.

Literature Cited:



Green Frog (*Rana clamitans*) ([E.Freeman](#))

Ecology: The green frog is a large sized frog with adults ranging in size from two to four inches in length. Life span in the wild is unknown, but captive frogs have been known to

live up to ten years. Males and females are phenotypically different. Males have a tympanum that is larger than their eyes as well as having a yellow throat where females have a tympanum that is the same size as their eyes as well as having a white throat. Both sexes have prominent dorsolateral ridges. Both sexes also have dark, transverse bands on their legs as well as well webbed toes. The first fingers do not extend past the second. There are various color phases including bronze, brown, light green and in very rare cases, blue.

Green Frogs are both diurnal and nocturnal, living and around shallow water. When cold whether months arrive they go dormant until it warms again. Green Frogs are a solitary species except during breeding season when they congregate at breeding locations. Males guard their breeding territory which is approximately one to six meters in diameter and sing to attract females. These frogs also have excellent vision which is used to locate prey. Green Frogs are carnivorous and will eat anything they can get into their mouth. They employ the sit and wait hunting tactic to capture their prey.

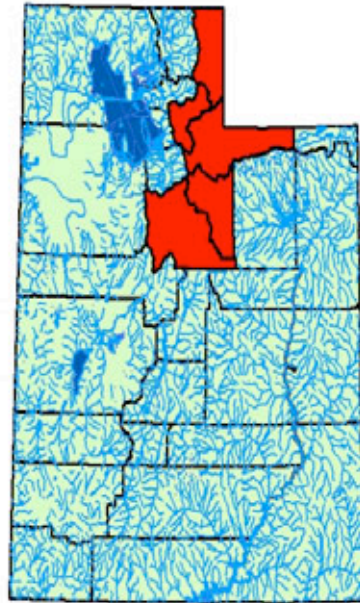
Breeding takes place in late spring and lasts between one to three months. Each female produces 1,000 to 7,000 eggs. These eggs are attached to emergent aquatic vegetation or they will float on the surface of the water. Gestation takes three to five days. After hatching the tadpole stage is completed in 3 to 22 months.

Distribution: Green Frogs are native to the eastern United States. They are currently found along the northern Wasatch front in the following Utah counties: Rich, Morgan, Summit, Wasatch and Utah.

Pathways of Introduction: While native to the eastern United States they were likely introduced to the West by way of the pet trade. As their populations grow they will continue to spread throughout the West.

Management Concerns: While not as gregarious as the Bullfrog, the Green Frog does pose a threat to native species. They compete for food and other resources with native fauna, including the threatened Boreal Toad. There are natural predators to these frogs as well as native species including birds and snakes. There are no management efforts that specifically target this species.

Green Frog
Rana clamitans



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Plains Leopard Frog (*Rana Blairi*) (C.Stock)

Ecology:

The plains leopard frog is about 2.8-3.9 inches long. Its background is brown or green, and has two or three irregular rows of dark spots on the dorsum. This species is often confused with the northern leopard frog (*Rana pipiens*), but it can be distinguished because of a light spot in the middle of the tympanum, a distinct light line along the upper jaw, and dorsolateral ridges that are interrupted just anterior to the groin and medially. It is usually found in streams, reservoirs, ponds, ditches, and other bodies of water.

Breeding occurs in spring and summer. Large egg clusters are attached to submerged vegetation in waters without a strong current.

Distribution: The Plains Leopard Frog is found throughout the Great Plains of the United States, from Indiana west across central and southern plains to South Dakota, south to Colorado, New Mexico, and Texas, with a disjunct population in Arizona. Its current distribution in Utah is the Wahweap area of Lake Powell.

Pathways of Introduction: Most likely introduced by trailered boats into the marina.

Management Considerations: Manual removal can be done at night with a flashlight shined into their eyes. This can be done by gig or by hand. There are also various types of traps that can be set up.

Literature Cited:

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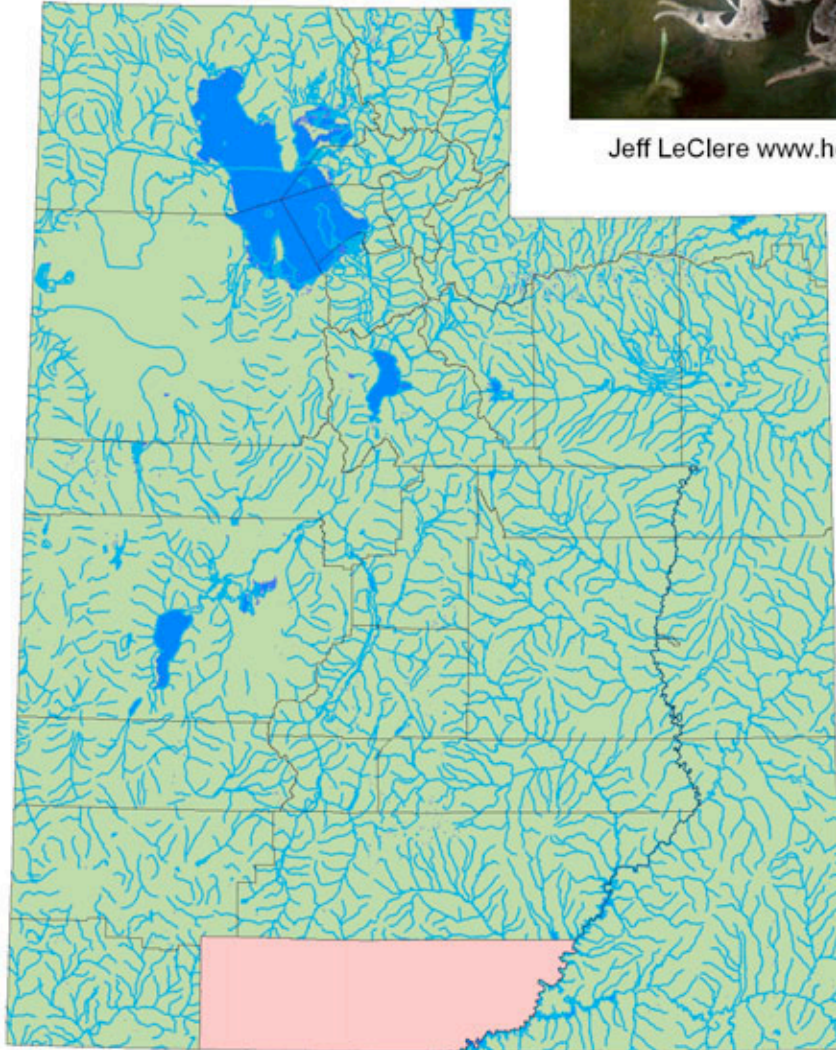
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Plains Leopard Frog- *Rana Blairi*

 Current Distribution of
Plains Leopard Frog



Jeff LeClere www.herpnet.net

Rio Grande Leopard Frog (*Rana berlandieri*) (C.Stock)

Ecology: The Rio Grande Leopard frog is a highly aquatic frog that is typically found in streams. It is rarely found away from water but can survive by burrowing into moist soils. It is mostly active at night and seldom seen during the day. The diet consists of a wide

variety of insects, aquatic prey, and even other frogs. Mating generally occurs after rainfall year round, and generally egg masses are attached to aquatic vegetation.

The coloring pattern is pale green, olive, or a grayish brown. They have dorsal spots that are dark with a light rim, and the thighs have dark reticulations. The frogs also have prominent dorsolateral folds that turn inward in front of the groin. A light stripe also runs along the jaw but fades or completely disappears in front of the eye. Adults are 2.25 – 4.25 inches long from snout to vent.

Distribution: Native to Texas, New Mexico, and Mexico. It is not currently found in Utah, but exists nearby.

Pathways of Introduction: Most likely introduced from trailered boats.

Management considerations: Manual removal can be done at night with a flashlight shined into their eyes. This can be done by gig or by hand. There are also various types of traps that can be utilized.

Literature Cited:

Behler, John L., & F. Wayne King. *The Audubon Society Field Guide to North American Reptiles and Amphibians*. Alfred A. Knopf, 1992.

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Rio Grande Leopard Frog- *Rana Berlandieri*

 Current Distribution of
Rio Grande Leopard Frog

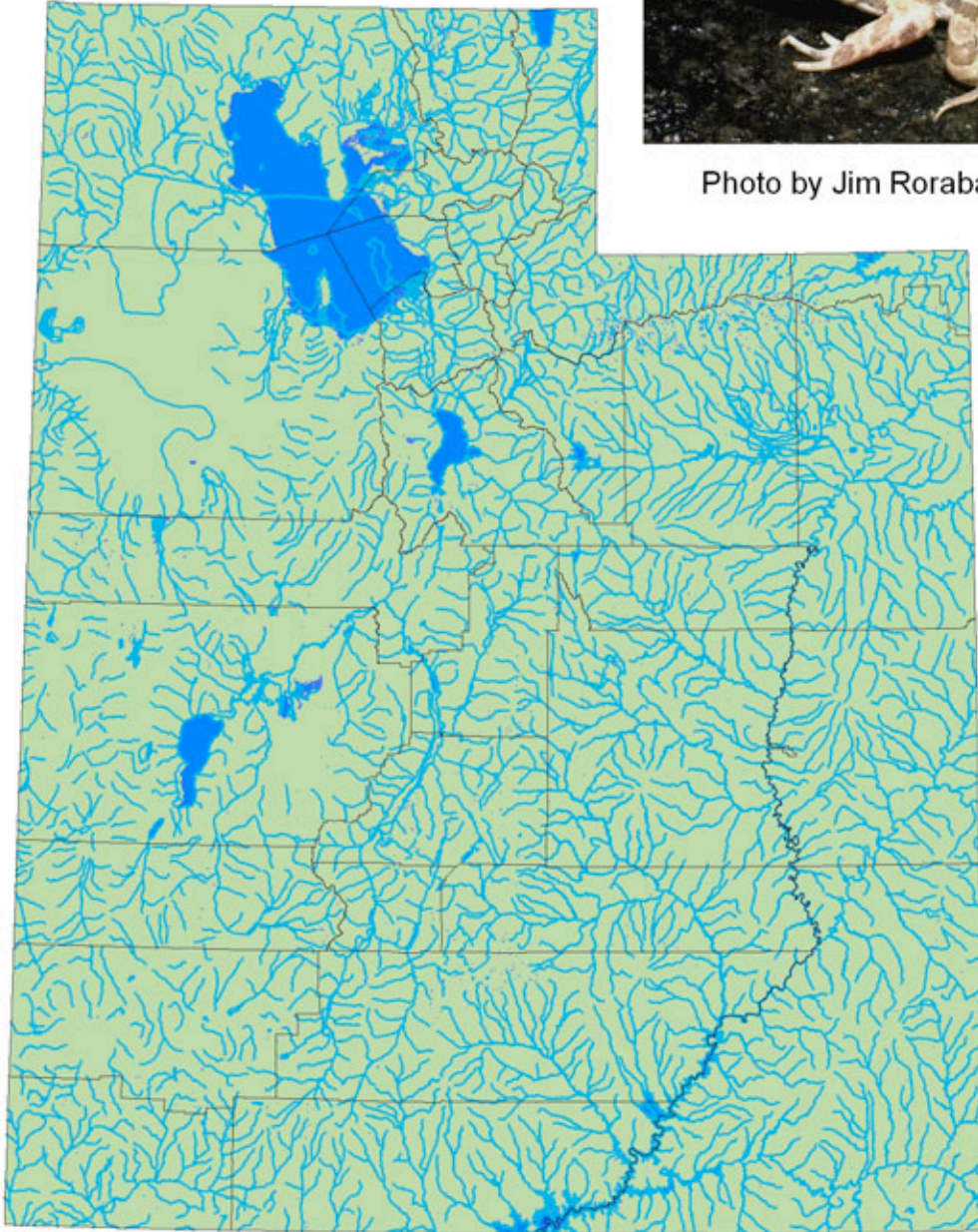


Photo by Jim Rorabaugh

Reptiles

Red-Eared Slider (*Trachemys scripta elegans*) (C.Stock)

Ecology:

Red-eared sliders are an aquatic turtle that is commonly sold in the pet trade. The tympanum is covered with red. The back is dark green with black and cream stripes, while the belly has black markings on a cream background. The carapace length of females is 8 inches and males 5-6 inches. Female's shells are domed. The underside of the male's shell is concave, and they have a longer tail than females. Males also have long claws, which is used for mating.

These turtles are often found in fresh and brackish waters, and are a problem because they compete with native aquatic turtles for food. Red-eared sliders are omnivores, and will eat worms, snails, crayfish, small fish, insects, and aquatic plants.

Distribution: Red-eared sliders are native to the Mississippi Valley area of the United States. They currently have established populations in the Washington County and the Weber County areas of Utah.

Pathways of Introduction: Owners release them as they reach adulthood.

Management Considerations: These have become a problem because they are often released into the wild, and they have established populations throughout the United States. Red-eared sliders can be caught using various traps including; floating baited traps, and floating basking traps. Eggs can also be manually removed from females nesting areas. This however must only be done by someone who knows the species very well, and by careful observation.

Literature Cited:

Cadi, A., and Joly, P. 2003. Competition for basking places between the endangered European pond turtle (*Emys orbicularis galloitalica*) and the introduced red-eared slider (*Trachemys scripta elegans*). *Canadian Journal of Zoology* 81: 1392-1398

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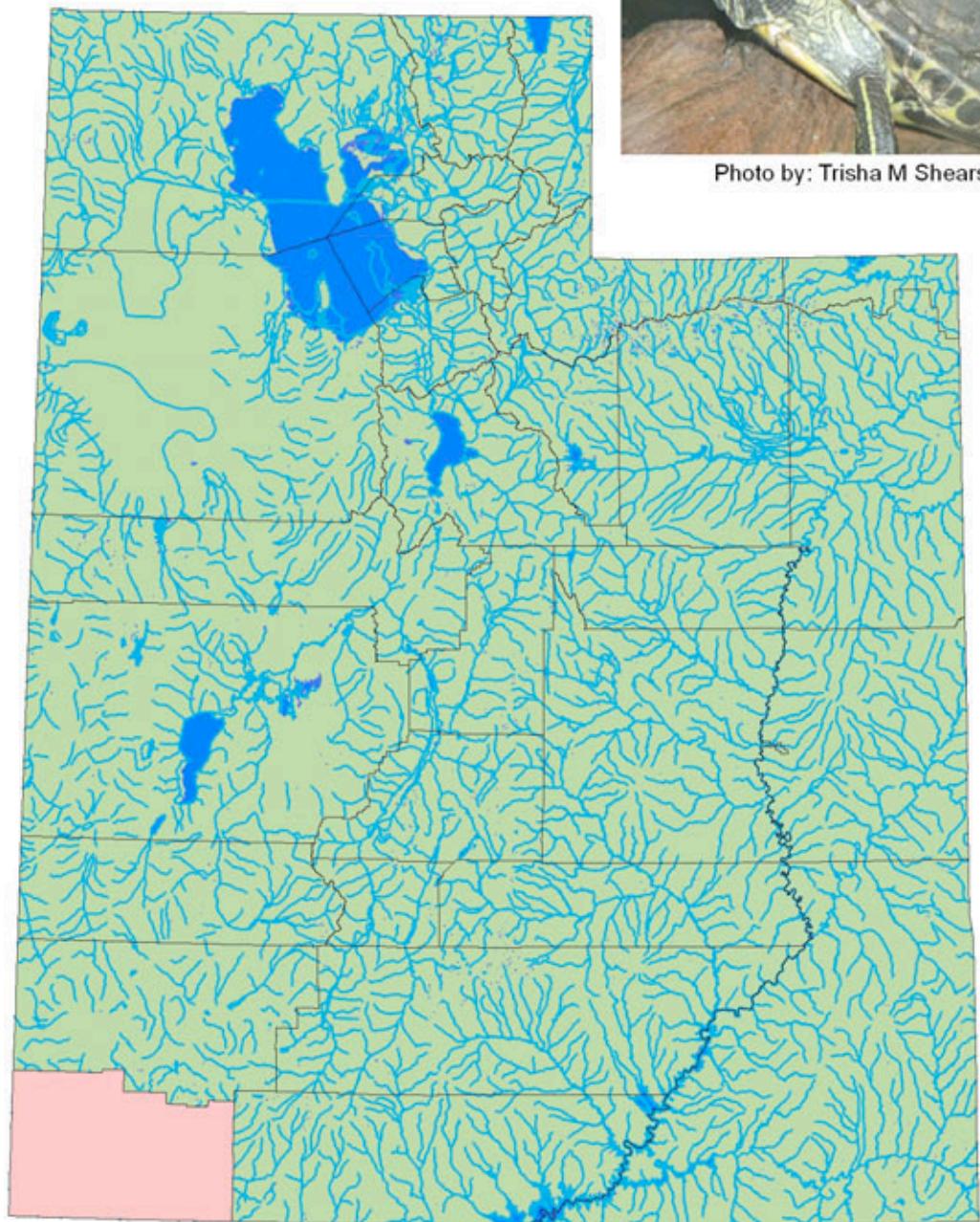
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Red-Eared Slider-*Trachemys scripta elegans*

 Current Distribution of Red Eared Slider



Photo by: Trisha M Shears



New Mexico Whiptail ([E.Freeman](#))

Other ([Note: Reference other authorities \(e.g. Dept Ag ???\)](#) ([intro L.Dalton](#))

APPENDIX B

STATE OF UTAH	REF.	PAGE
DEPARTMENT OF NATURAL RESOURCES	NR-07-D-11	1 of 5
POLICIES AND PROCEDURES	EFFECTIVE DATE	03/19/07
SUBJECT:	REVISION DATE	
Prevent Invasion Of Zebra Mussel Into Utah Waters		
Michael R. Styler, Executive Director		

I. PURPOSE

To define the policy of the Department of Natural Resources (Department) that will provide direction on the prevention of Zebra mussel infestation into Utah's waters.

II. POLICY

It is the policy of the Department to prevent the infestation of Zebra mussel (*Dreissena* sp.) into Utah's waters. Divisions of the Department will cooperate and provide resources to prevent infestation by:

- a. Planning and implementing interdiction and containment efforts to prevent infestation of Zebra mussel into Utah's waters.
- b. Assisting with monitoring efforts to document the absence or presence of Zebra mussel.
- c. Informing the public on Zebra mussel impacts, prevention measures, and monitoring updates; and
- d. Inviting other government agencies (including adjoining states) and non-governmental organizations to participate and provide resources (interdiction, monitoring, and conservation outreach) to prevent infestation of Zebra mussel into Utah's waters. The development of cooperative agreements with these agencies and organizations may be considered as part of this mutual process.

III. AUTHORITY

Authority is vested under Sections 23-13-5 and 23-20-1 of the Utah Wildlife Code. The Utah Wildlife Board, under Rule 657-3-22 (w) for Collection, Importation and Possession of wildlife species in Utah, identified *Dreissena* species as prohibited.

STATE OF UTAH	REF.	PAGE
DEPARTMENT OF NATURAL RESOURCES	NR-07-D-11	2 of 5
POLICIES AND PROCEDURES	EFFECTIVE DATE	03/19/07
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SUBJECT: Prevent Invasion Of Zebra Mussel Into Utah Waters		
Michael R. Styler, Executive Director		

IV. PROCEDURE

a. Prevention:

The Department will take the lead in reconvening the state's Aquatic Nuisance Species (ANS) Team to address the prevention of Zebra mussel infestation into Utah. The ANS Team will include those affected parties wishing to participate.

- i. The Division of Wildlife Resources is designated as the lead Division for the Department.
- ii. The Department will ask the ANS Team to assist in developing cooperative interdiction efforts between the Department, National Park Service, other federal agencies, inter- and intra-state agencies and their respective agencies, municipalities, public utilities, private industry and other relevant parties that address preventative measures for Zebra mussel infestation. Interdiction efforts include, but are not limited to, law enforcement checks and boat and equipment disinfection. The initial interdiction efforts have been started at the Lake Powell National Recreation Area due to its proximity to infected waters and high boating use.
- iii. The Department will assist the ANS Team in conducting a risk assessment of Utah waters with high potential for Zebra mussel infestation. Thereafter the Department will help direct long-term interdiction efforts on these prioritized state waters (e.g., Quail Creek, Sand Hollow, and Gunlock reservoirs).
- iv. The ANS Team will be strongly urged by the Department to support the interagency development of individual Hazard Analysis and Critical Control Point (HACCP) plans at these high-risk waters.
- v. The Department will assist the ANS Team in identifying and pursuing cooperative funding packages for the interdiction efforts to support increased boat checks at high-risk waters, and development of boat cleaning stations that follow 100th Meridian protocol. (See www.100thMeridian.org).

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POLICIES AND PROCEDURES	EFFECTIVE DATE	03/19/07
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Prevent Invasion Of Zebra Mussel Into Utah Waters		
Michael R. Styler, Executive Director		

- vi. The Department will ask the ANS Team to coordinate their interdiction efforts with those Department Divisions with law enforcement authority and the Utah Attorney General's office to review, clarify and pursue laws and rules that will help with these prevention measures.

b. Monitoring:

The Department will support the ANS Team to cooperatively develop and implement monitoring efforts at priority waters, based on the aforementioned risk assessment, to determine the presence or absence of Zebra mussel. Monitoring has already been started at Lake Powell. The Department will assist with the following:

- i. Use monitoring protocol identified by the 100th Meridian group to insure continuity throughout interstate water systems.
- ii. Identify and pursue cooperative funding packages within the monitoring programs to support biologically sound sampling methods, and a long term Zebra mussel database housed within the Department.
- iii. Coordinate monitoring efforts with public water utilities and private industry to help track infestation potential. All monitoring will provide annual sampling results for the Department's Zebra mussel database.

c. Conservation Outreach:

The Department will support the ANS Team to cooperatively develop and implement conservation outreach efforts to prevent Zebra mussel infestation into state waters.

- i. The Department will assist the ANS Team in developing and utilizing public information signs, media coverage and messages (e.g., brochures) consistent with other states and the 100th Meridian group related to Zebra mussel infestation. Immediate efforts should be directed toward Lake Powell, as well as other high-risk waters.
- ii. The Department will coordinate with other states and the 100th Meridian to develop common messages, and to share information on infestation reports or possible management/control research.

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DEPARTMENT OF NATURAL RESOURCES	NR-07-D-11	4 of 5
POLICIES AND PROCEDURES	EFFECTIVE DATE	03/19/07
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Prevent Invasion Of Zebra Mussel Into Utah Waters		
Michael R. Styler, Executive Director		

- iii. The Department will work with interested partners to develop a long-term education program to inform the public of the need for proper boating disinfection when moving between waters.

V. BACKGROUND

The state of Utah, under direction of the Department of Natural Resources, recognizes that *Dreissena* mussels (commonly referred to as Zebra mussels) are a harmful aquatic nuisance species not native to Utah. They originate from the drainage systems of the Black and Caspian seas in Eastern Europe. These mussels were first discovered in the United States in the Great Lakes (Lake St. Clair) around 1986-1988. Since that time, Zebra mussels have spread throughout the eastern United States due to the absence of natural predators, high reproductive potential, adaptability to available aquatic habitats, and unintentional human transport. Expanding populations of these species are now found throughout the Mississippi, Missouri, and Arkansas River drainages. Reported densities from the Great Lakes area are over 100,000 mussels per square meter at some facilities.

One of the *Dreissena* mussel species (Quagga mussel) was recently discovered during January 2007 in Lake Mead and other downstream reservoirs of the lower Colorado River. This finding in the Colorado River system expands the documented range of invasion by over 1000 miles from previously known locations to the east. The proximity of these reservoirs to those located upstream in Utah significantly increases the risk that *Dreissena* mussels could infest state waters. Infestation events are usually first documented in or around boating facilities on waters, indicating a strong correlation to their being transported through boating and other aquatic related activities. Irrigation and other water delivery systems, common throughout Utah's arid environments, are other pathways whereby aquatic invasive species can be transported.

The infestation of *Dreissena* mussels (hereafter called Zebra mussels) in the eastern United States has caused millions of dollars of economic loss to public agencies and private industry. Zebra mussel can severely hinder the delivery of

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Michael R. Styler, Executive Director		

water for domestic, municipal, industrial, and agricultural purposes due to their ability to clog or foul pipes, pumps, water intake screens, water treatment facilities, power plant intakes and cooling systems, and fish screens. The boating industry incurs additional recreation costs associated with boat and motor damage, cleaning costs, and disinfection needs required for containment at infected waters. Public safety has also been documented as a hazard to those using the beach areas on recreational waters (unprotected feet) due to the sharpness of the bivalve shells.

Ecologically, zebra mussels alter aquatic environments by filtering from the water the essential nutrients and green algae that form the base of the food chain required by native species and sport fish for growth and survival. A major concern is the potential impacts from infestation to Utah's native sensitive species, which have already declined to low population levels due to other negative factors such as habitat loss. Other concerns include potential impacts to important recreational fisheries and the potential to interfere with irrigation, municipal and industrial water delivery facilities.

Several years ago, a group was formed under the direction of the U.S. Fish and Wildlife Service to address the spread of invasive species, such as Zebra mussels. The group was named the "100th Meridian" because Zebra mussels were not found west of this longitude line at the time of organization. To date there is no known method to eradicate them after establishment. Prevention through education and interdiction are the first lines of defense against invasion of these species. The 100th Meridian group has facilitated communication and cooperative efforts among stakeholders to educate and contain Zebra mussels; and to share current management ideas on limiting impacts from them once infestation has occurred.

To protect and preserve public safety of Utah's citizens, its critical water resources and uses, the economy of its aquatic based recreation and its valuable fish and wildlife resources, the Department of Natural Resources has developed a policy that will provide direction on the prevention of infestation of Zebra mussels into the State's waters. This policy also addresses the need to form partnerships with other governmental agencies and private industry to coordinate and ensure its successful implementation.

APPENDIX C

BUDGET REQUEST

For

“A QUAGGA MUSSEL EDUCATION AND IMPLEMENTAION PLAN”

Utah Department of Natural Resources

Utah Division of Wildlife Resources

Preparer: Walt Donaldson, Aquatic Chief

October 3, 2007

- A. **Proposal:** To educate the public about aquatic nuisance species, particularly Quagga and Zebra mussel impacts, and prevent their invasion into Utah's waters.
- B. **Work Schedule:** Fiscal Year 2008 & 2009
- C. **Authority:** 1) UCA Title 23, Wildlife Code; 2) Rule 657-3, Collection, Importation and Possession of zoological Animals; and 3) DNR Policy #NR-07-D-11, "Prevent Invasion of Zebra Mussel into Utah Waters"
- D. **Need:** Quagga and Zebra mussels are exotic, invasive species from east central Russia that annually have caused millions of dollars of impacts to water resource based industries and water recreation in the eastern United States over the last two decades. Quagga mussels were discovered in Lake Mead on the lower Colorado River in January 2007. Then, in August 2008 veligers (microscopic larval form of Quagga and Zebra mussels), presumably of Quagga mussels due to the proximity of Lake Mead, were identified in Lake Powell.

The purpose of this proposal is to fund a program to educate the public about aquatic nuisance species, particularly Quagga and Zebra mussel impacts, and prevent their invasion into other Utah waters. Within Utah there are 21 boating lakes and reservoirs that have state park facilities, and there are 46 boating lakes and reservoirs without a state park. The state of Minnesota, "land of 10,000 lakes," has been very successful in limiting expansion of invasive mussel species in their waters through aggressive education and prevention efforts. This proposal is patterned after Minnesota's plan.

E. **Tasks:**

1. Administration and Monitoring (Aquatic Section)

- Administer and coordinate interagency education and prevention efforts statewide, particularly with both state and local water conservation agencies.

- Develop and implement a strategic plan and associated action plans regarding aquatic nuisance species in cooperation with participating agencies (e.g. water conservation districts, local governments, federal and state land and natural resource management agencies, NGO organizations and other private partners) to prevent or slow the spread of invasive species infestation within Utah.
- Take the lead on work planning, evaluation, budget development, monitoring and reporting.
- Conduct risk assessments of key state waters and prioritize them based on their potential for invasion or containment of an invasion.
- Recruit, train and supervise 5 Wildlife Biologist I (AL) and 22 seasonal (AJ) Wildlife Technicians on how to:
 - a) Educate the public about aquatic nuisance species and mussel impacts;
 - b) Conduct approved inspections for Quagga and Zebra mussels on or contained within watercraft;
 - c) Conduct approved inspections for Quagga and Zebra mussels on watercraft hauling vehicles and trailers;
 - d) Conduct approved inspections for Quagga and Zebra mussels on water-related recreational equipment; and
 - e) Conduct biological sampling for Quagga and Zebra mussels.
- Implement watercraft inspections for Quagga and Zebra mussels at Utah's high-risk lakes and reservoirs to insure compliance, and compel watercraft users or haulers to decontaminate boats, trailers, and water-related recreational equipment as needed, particularly those originating from waters with high invasive potential for Quagga and Zebra mussels.
- Distribute educational or outreach materials on invasive species as needed.
- In cooperation with land management agencies, install and maintain Quagga and Zebra mussel and/or aquatic nuisance species signs on all major lakes and reservoirs in Utah.
- Conduct biological sampling for Quagga and Zebra mussels in high-risk lakes and reservoirs throughout the state.
- Develop and maintain a database to track results from biological sampling of Quagga and Zebra mussels.
- Review technology and research updates on invasive mussel control and prevention.

2. Interdiction (Law Enforcement Section)

- Recruit, train and supervise 5 Conservation Officers on how to:
 - a) Educate the public about aquatic nuisance species and mussel impacts;
 - b) Conduct approved inspections for Quagga and Zebra mussels on or contained within watercraft;
 - c) Conduct approved inspections for Quagga and Zebra mussels on watercraft hauling vehicles and trailers;
 - d) Conduct approved inspections for Quagga and Zebra mussels on water-related recreational equipment; and

- e) Conduct biological sampling for Quagga and Zebra mussels; and
- f) Insure compliance with Utah's laws and rules.
- Implement watercraft inspections for Quagga and Zebra mussels at Utah's high-risk lakes and reservoirs to insure compliance, and compel watercraft users or haulers to decontaminate boats, trailers, and water-related recreational equipment as needed, particularly those originating from waters with high invasive potential for Quagga and Zebra mussels.
- Distribute educational or outreach materials on invasive species as needed.
- In cooperation with land management agencies, install and maintain Quagga and Zebra mussel and/or aquatic nuisance species signs on all major lakes and reservoirs in Utah.
- Conduct biological sampling for Quagga and Zebra mussels in high-risk lakes and reservoirs throughout the state.
- Implement boat and watercraft inspections for mussels at Utah's high-risk lakes and reservoirs, insure compliance, and collect biological samples from selected waters.
- Compel watercraft users or haulers to decontaminate boats, trailers, and water-related recreational equipment as needed.

Public Education and Information (Conservation Outreach Section)

- Recruit, train and supervise 1 Conservation Outreach Coordinator on how to educate DNR personnel, participating agencies and the public about aquatic nuisance species, particularly Quagga and Zebra mussel impacts, and prevention methods.
- Develop and implement a conservation outreach plan for aquatic nuisance species, particularly Quagga and Zebra mussels.
- Design and update printed education materials on aquatic nuisance species, particularly invasive mussels, in consultation with the Aquatic Nuisance Species Coordinator.
- Maintain and update the DWR website on aquatic nuisance species, particularly invasive mussels, and prevention efforts in consultation with the Aquatic Nuisance Species Coordinator.
- Conduct media coordination and advertisement to insure public awareness of the threat from aquatic nuisance species, particularly invasive mussels, and prevention methods.
- Develop and implement education plans to inform and train the boating industry about the threat from aquatic nuisance species, particularly invasive mussels, and prevention methods.

4. Cooperative Containment Efforts (Aquatic Section)

- Develop and implement action plans as needed for containment of aquatic nuisance species in cooperation with participating agencies (e.g. water conservation districts, local governments, federal and state land and natural resource management agencies, NGO organizations and other

private partners) to prevent the spread of invasive species from infested waters, particularly Quagga and Zebra mussels as follows:

- a) Specifically and immediately focus upon Lake Powell.
 - b) Appropriately monitor for aquatic nuisance species infestations (e.g. collect zooplankton in reservoirs near high boat density sites—marinas, implement Portland substrate samplers, make visual inspections of underwater habitats using scuba equipment, and inspect intake and outlet or other plumbing structures). Then, submit samples as needed to qualified experts or labs as verification for presence or non-presence of aquatic nuisance species. **Note:** Regarding Lake Powell, analysis from the US Bureau of Reclamation lab in Denver, CO indicates extreme low densities of the Quagga mussel juveniles.
 - c) Focus upon other state waters as needed;
 - d) Cooperatively develop appropriate containment messages.
- Direct and coordinate efforts involving the use of conservation officers, biologists, wildlife technicians and participating agency personnel in contacting as many boaters and anglers as possible about aquatic nuisance species, particularly Quagga and Zebra mussels, to insure that watercraft enter and leave Utah's waters as "uncontaminated" (clean).

ESTIMATED BUDGET COSTS

FY 2008: \$1,106,500

Supplemental Appropriation

* See Excell File: FY08 Budget & Personnel Distribution for Sheehan.xls

FY 2009: \$1,640,000

Building Block Appropriation

* See Excell File: FY09 Budget & Personnel Distribution for Sheehan.xls

UTAH FISHING LAKES AND RESERVOIRS USED BY BOATERS

June 2008

Risk Ranking: 1 = highest; 2 = high; 3 = moderate; 4 = low; 5 = little to no risk

**UDWR-NRO (Rank 1-5 & Recommendation
Provided by Schaugaard 6-27-07)**

1-Bear Lake SP, 2 inspectors & 1 boat decontamination unit

3-Cutler Reservoir

3-Newton Reservoir

4-Whitney Reservoir

4-Stateline Reservoir

5-Birch Creek Reservoir (no ramp)

4-Woodruff Reservoir

1-Pineview, 2 inspectors & 1 boat decontamination unit

5-Causey Reservoir (no ramp)

2-East Canyon SP, \

2-Rockport SP } 1 Inspector & 1 boat decontamination unit

2-Echo Reservoir /

4-Smith & Morehouse

4-Stateline Reservoir

4-Lost Creek Reservoir

1-Willard Bay SP, 2 inspectors & 1 boat decontamination unit

2-Hyrum SP,

2-Mantua Reservoir

4-Porcupine Reservoir

1-I-80 port (?)

**UDWR-NERO (Rank 1-5 & Recommendation
Provided by Schneidervin 7-03-07)**

1-Flaming Gorge, 4 inspectors & 2 boat decontamination units

3-Calder Reservoir

3-Crouse Reservoir

3-Matt Warner Reservoir

3-Red Fleet SP and Steinaker SP, 1 inspector & 1 boat decontamination unit

4-Bough Reservoir

- 4-East Park Reservoir
- 4-Bullock Reservoir
- 4-Cottonwood Reservoir (low boat use)
- 1-Pelican Lake (due to tournaments), 1 inspector & 1 boat decontamination unit
- 3-Starvation SP, 1 inspector & 1 boat decontamination unit
 - 4-Currant Creek Reservoir
 - 4-Moon Lake
 - 4-Big Sandwash Reservoir
 - 5-Upper Stillwater Reservoir (no ramp)

UDWR-CRO (Rank 1-5 & Recommendation Provided by Wiley 6-28-07)

- 1-Strawberry Reservoir, 2 inspectors & 1 boat decontamination unit
- 1-Jordanelle SP, 2 inspectors & 1 boat decontamination unit (1% non-resident use from WY & NB, but Lk Mead destination)
- 2-Deer Creek SP, 1 inspector & 1 boat decontamination unit (low non-resident use)
- 2-Yuba SP, 1 inspector & 1 boat decontamination unit (8% non-resident use)
 - 5-Gunnison Reservoir (no ramp & 3 miles dirt road for access)
- 4-Utah Lake SP, 2 inspectors & 1 boat decontamination unit
 - 5-Mona Reservoir (poor sport fishery)

UDWR-SERO (Rank 1-5 & Recommendation Provided by Birdsey 7-03-07)

- 1-Huntington North SP, 1 inspector & 1 boat decontamination unit
 - 3-Electric Lake
 - 3-Mammoth Reservoir
- 2-Millsite SP, 1 inspector & 1 boat decontamination unit
 - 2-Joes Valley Reservoir
- 1-Scofield SP, 1 inspector & 1 boat decontamination unit

Lake Powell

- 1-Bullfrog, 2 inspectors (NPS has 1 boat decontamination unit)
- 1-Hall's Crossing, 1 inspector (NPS has 1 boat decontamination unit)
- NOTE:** Vehicle may be needed for technician who works Hall's Crossing, since the Technician would be housed at Bullfrog

5-Hite- cannot launch boats there in 2007, unknown 2008

Medium Risk Waters

3-Recapture Reservoir

Low Risk Waters:

4-Blanding #4

4-Kens's Lake

1-I-70 port (?)

UDWR-SRO (Rank 1-5 & Recommendation Provided by Ottenbacher 6-27-07)

1-Gunlock, Quail Creek and Sand Hollow SP, 3 inspectors & 2 boat decontamination units (Mar-Nov)

3-Upper and Lower Enterprise

3-Newcastle Reservoir

5-Fish Lake, 1 inspector & 1 boat decontamination unit (May-Aug)

2-Koosharem Reservoir

3-Otter Creek SP and Piute SP, 2 inspectors & 1 boat decontamination unit (April-Labor Day)

2-Minersville Reservoir, 1 inspector & 1 boat decontamination unit (April-Labor Day)

NOTE: County operated

1-Panguitch Lake, 1 inspector & 1 boat decontamination unit (May-Labor Day)

4-Navaho Lake

4-Kolob Reservoir

1-Lake Powell

Wahweap & Antelope Point/Stateline, 2 inspectors & NPS has 2 boat decontamination units (Mar-Nov)

1-I-15 Port of Entry, 2 inspectors & 2 boat decontamination units? (Mar-Nov)

1-West Lake Mead Access Pts, 1 contactor (Mar-Nov)

APPENDIX D

UTAH DIVISION OF WILDLIFE RESOURCES NEW ZEALAND MUD SNAIL (*Potamogyrus antipodeticus*) MANAGEMENT PLAN FOR LOA HATCHERY Tina Miles, Plant Coordinator March 3, 2008

Loa State Fish Hatchery Status

The aquatic invasive species New Zealand Mud Snail (NZMS) was found in the main spring complex and throughout the outside cement rearing system at the Loa Hatchery in late November 2007. Springs providing water for the hatchery building and truck loading system have remained free of NZMS. The Loa Hatchery is owned and operated by the Utah Division of Wildlife Resources (Division).

Purpose

To develop a NZMS management plan that addresses both the short term and long-term direction for the Loa Hatchery.

Short Term strategy for decontamination of the existing trout stocks on station.

To determine extent of the NZMS infestation in fish groups at the Loa Hatchery, the staff sampled 100 fish from rearing units in the hatchery building and 100 fish from the large outside raceways. The stomachs and digestive tracts of each fish were physically examined for the presence of snails. Snails were to be identified as either an unknown native species or NZMS, but no snails were found in any of the fish sampled. These fish stocks will continue to be sampled at least quarterly until a determination is made to either stock them in waters already containing NZMS or destroy the fish.

1. Protocols for stocking infested fish from the Loa Hatchery into NZMS infested waters:
 - a. A minimum of quarterly, sample 100 fish from the hatchery building and 100 fish from the outside raceway system to determine the presence of NZMS. Each fish's stomach and digestive tract will be examined for the presence of snails by tactile, ocular and microscopic inspection.
 - b. Fish scheduled for stocking will be placed in the raceway system that has been cleaned as follows:
 - i. Use a high-pressure hot water washer, spraying 180 degree F. water at a point 12 inches from the nozzle, to remove all sludge, vegetation, and snails, paying particular attention to seams, corners, crevices, carbon channels and backing boards.
 - ii. After pressure washing, spray the inside of the raceway with a quaternary ammonium compound that contains the active ingredient - Alkyl dimethyl benzyl ammonium chloride (ADBAC), at a concentration of 5.0%. Then, allow the raceway to stand for 48 hours, if possible.
 - iii. The cleaned and disinfected raceway will be filled with filtered water from the hatchery building water supply.

Appendix E1

Aquatic Invasive Species Interdiction Act

1st Sub. S.B. 238

LEGISLATIVE GENERAL COUNSEL

6 Approved for Filing: E.R. Brown 6

6 02-25-08 11:52 AM 6

S.B. 238

1st Sub. (Green)

SB0238S01

Senator Jon J. Greiner proposes the following substitute bill:

1 **AQUATIC INVASIVE SPECIES**

2 **INTERDICTION ACT**

3 2008 GENERAL SESSION

4 STATE OF UTAH

5 **Chief Sponsor: Jon J. Greiner**

6 House Sponsor: Stephen H. Urquhart

7

8 **LONG TITLE**

9 **General Description:**

10 This bill amends and enacts provisions relating to the interdiction of invasive species.

11 **Highlighted Provisions:**

12 This bill:

13 < defines terms;

14 < prohibits the possession, release, or transportation of a *Dreissena* mussel;

15 < prohibits the transporting of a conveyance or equipment that has been in an infested
16 water without decontaminating the conveyance or equipment;

17 < requires a person who violates the chapter to reimburse the state's costs;

18 < establishes criminal penalties;

19 < authorizes the Division of Wildlife Resources to:

20 C stop, detain, inspect, impound, or quarantine a vehicle or vessel that may
21 contain a *Dreissena* mussel;

22 C conduct an administrative checkpoint;

23 C order a person to decontaminate a vessel or vehicle; and

24 C inspect, restrict access to, or close a water body, facility, or water supply system;

25 < prohibits the Division of Wildlife Resources from closing or quarantining a water

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26 supply system if a plan is implemented;

27 < requires the Division of Wildlife Resources to consult with an operator of a water
28 body, facility, or water supply system;

29 < requires a water supply system to cooperate with the Division of Wildlife Resources
30 and implement a plan if infected with the Dreissena mussel;

31 < requires a person to report the discovery of a Dreissena mussel to the Division of
32 Wildlife Resources;

33 < authorizes the Wildlife Board to make rules; and

34 < authorizes the division, a peace officer, or a port-of-entry agent to stop a driver at a
35 port-of-entry to check for invasive aquatic wildlife species.

36 Monies Appropriated in this Bill:

37 None

38 Other Special Clauses:

39 None

40 Utah Code Sections Affected:

41 AMENDS:

42 **72-9-501**, as last amended by Laws of Utah 2005, Chapter 2

43 ENACTS:

44 **23-27-101**, Utah Code Annotated 1953

45 **23-27-102**, Utah Code Annotated 1953

46 **23-27-201**, Utah Code Annotated 1953

47 **23-27-202**, Utah Code Annotated 1953

48 **23-27-301**, Utah Code Annotated 1953

49 **23-27-302**, Utah Code Annotated 1953

50 **23-27-303**, Utah Code Annotated 1953

51 **23-27-401**, Utah Code Annotated 1953

52

53 *Be it enacted by the Legislature of the state of Utah:*

54 Section 1. Section **23-27-101** is enacted to read:

**55 CHAPTER 27. AQUATIC INVASIVE SPECIES INTERDICTION
ACT**

56 Part 1. General Provisions

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57 23-27-101. Title.

58 This chapter is known as the "Aquatic Invasive Species Interdiction Act."

59 Section 2. Section **23-27-102** is enacted to read:

60 23-27-102. Definitions.

61 As used in this chapter:

62 (1) "Board" means the Wildlife Board.

63 (2) (a) "Conveyance" means a terrestrial or aquatic vehicle or a vehicle part that may
64 carry or contain a Dreissena mussel.

65 (b) "Conveyance" includes a motor vehicle, a vessel, a motorboat, a sailboat, a
personal

66 watercraft, a container, a trailer, a live well, or a bilge area.

67 (3) "Director" means the director of the division.

68 (4) "Decontaminate" means to:

69 (a) drain and dry all non-treated water; and

70 (b) chemically or thermally treat in accordance with rule.
71 (5) "Division " means the Division of Wildlife Resources.
72 (6) "Dreissena mussel" means a mussel of the genus Dreissena at any life stage,
73 including a zebra mussel, a quagga mussel, and Conrad's false mussel.
74 (7) "Equipment" means an article, tool, implement, or device capable of carrying or
75 containing:
76 (a) water; or
77 (b) a Dreissena mussel.
78 (8) "Executive director" means the executive director of the Department of Natural
79 Resources.
80 (9) "Facility" means a structure that is located within or adjacent to a water body.
81 (10) "Infested water" means a geographic region, water body, facility, or water supply
82 system within or outside the state that the board identifies in rule as carrying or
83 containing a
84 Dreissena mussel.
84 (11) "Water body" means natural or impounded surface water, including a stream,
85 river, spring, lake, reservoir, pond, wetland, tank, and fountain.
86 (12) (a) "Water supply system" means a system that treats, conveys, or distributes
87 water for irrigation, industrial, waste water treatment, or culinary use.

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88 (b) "Water supply system" includes a pump, canal, ditch, or pipeline.
89 (c) "Water supply system" does not include a water body.
90 Section 3. Section **23-27-201** is enacted to read:
91 **Part 2. Invasive Species Prohibited**
92 **23-27-201. Invasive species prohibited.**
93 (1) Except as authorized in this title or a board rule or order, a person may not:
94 (a) possess, import, export, ship, or transport a Dreissena mussel;
95 (b) release, place, plant, or cause to be released, placed, or planted a Dreissena mussel
96 in a water body, facility, or water supply system; or
97 (c) transport a conveyance or equipment that has been in an infested water within the
98 previous 30 days without decontaminating the conveyance or equipment.
99 (2) A person who violates Subsection (1):
100 (a) is strictly liable;
101 (b) is guilty of an infraction; and
102 (c) shall reimburse the state for all costs associated with detaining, quarantining, and
103 decontaminating the conveyance or equipment.
104 (3) A person who knowingly or intentionally violates Subsection (1) is guilty of a
105 class
106 A misdemeanor.

106 Section 4. Section **23-27-202** is enacted to read:

107 23-27-202. Reporting of invasive species required.

108 (1) A person who discovers a Dreissena mussel within this state or has reason to
109 believe a Dreissena mussel may exist at a specific location shall immediately report the

110 discovery to the division.

111 (2) A person who violates Subsection (1) is guilty of a class A misdemeanor.

112 Section 5. Section **23-27-301** is enacted to read:

113 Part 3. Enforcement

114 23-27-301. Division's power to prevent invasive species infestation.

115 To eradicate and prevent the infestation of a Dreissena mussel, the division may:

116 (1) temporarily stop, detain, and inspect a conveyance or equipment that:

117 (a) the division reasonably believes is in violation of Section 23-27-201; or

118 (b) is stopped at a port-of-entry;

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119 (2) require a motor vehicle transporting a conveyance or equipment to stop for an
120 inspection at a port-of-entry if the Department of Transportation authorizes the
division to use

121 the port of entry;

122 (3) conduct an administrative checkpoint in accordance with Section 77-23-104;

123 (4) detain and quarantine a conveyance or equipment as provided in Section
124 23-27-302;

125 (5) order a person to decontaminate a conveyance or equipment; and

126 (6) inspect the following that may contain a Dreissena mussel:

127 (a) a water body;

128 (b) a facility; and

129 (c) a water supply system.

130 Section 6. Section **23-27-302** is enacted to read:

131 23-27-302. Conveyance or equipment detainment or quarantine.

132 (1) The division, a port-of-entry agent, or a peace officer may detain or quarantine a
133 conveyance or equipment if:

134 (a) the division, agent, or peace officer:

135 (i) finds the conveyance or equipment contains a Dreissena mussel; or

136 (ii) reasonably believes that the person transporting the conveyance or equipment is
in

137 violation of Section 23-27-201; or

138 (b) the person transporting the conveyance or equipment refuses to submit to an
139 inspection authorized by Section 23-27-301.

140 (2) The detainment or quarantine authorized by Subsection (1) may continue for:

141 (a) up to five days; or

142 (b) the period of time necessary to:

143 (i) decontaminate the conveyance or equipment; and

144 (ii) ensure that a Dreissena mussel is not living on or in the conveyance or
equipment.

145 Section 7. Section **23-27-303** is enacted to read:

146 23-27-303. Closing a water body, facility, or water supply system.

147 (1) Except as provided by Subsection (6), if the division detects or suspects a
Dreissena

148 mussel is present in a water body, a facility, or a water supply system, the director or
the

149 director's designee may, with the concurrence of the executive director, order:

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150 (a) the water body, facility, or water supply system closed to a conveyance or
151 equipment;

152 (b) restricted access by a conveyance or equipment to a water body, facility, or water
153 supply system; or

154 (c) a conveyance or equipment that is removed from or introduced to the water body,
155 facility, or water supply system to be inspected, quarantined, or decontaminated in a
manner

156 and for a duration necessary to detect and prevent the infestation of a Dreissena
mussel.

157 (2) If a closure authorized by Subsection (1) lasts longer than seven days, the
division

158 shall:

159 (a) provide a written update to the operator of the water body, facility, or water supply
160 system every ten days on the division's effort to address the Dreissena infestation;
161 and
162 (b) post the update on the division's website.
163 (3) (a) The board shall develop procedures to ensure proper notification of a state,
164 federal, or local agency that is affected by a Dreissena mussel infestation.
165 (b) The notification shall include:
166 (i) the reasons for the closure, quarantine, or restriction; and
167 (ii) methods for providing updated information to the agency.
168 (4) When deciding the scope, duration, level, and type of restriction or a quarantine
169 or
170 closure location, the director shall consult with the person with the jurisdiction,
171 control, or
172 management responsibility over the water body, facility, or water supply system to
173 avoid or
174 minimize disruption of economic and recreational activity.
175 (5) (a) A person that operates a water supply system shall cooperate with the division
176 to implement a measure to:
177 (i) avoid infestation by a Dreissena mussel; and
178 (ii) control or eradicate a Dreissena mussel infestation that may occur in a water
179 supply
180 system.
181 (b) (i) If a Dreissena mussel is detected, the water supply system's operator, in
182 cooperation with the division, shall prepare and implement a plan to control or
183 eradicate a
184 Dreissena mussel within the water supply system.
185 (ii) A plan required by Subsection (5)(b)(i) shall include a:
186 (A) method for determining the scope and extent of the infestation;
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181 (B) method to control or eradicate the Dreissena mussel;
182 (C) method to decontaminate the water supply system containing the Dreissena
183 mussel;
184 (D) systematic monitoring program to determine a change in the infestation; and
185 (E) requirement to update or revise the plan in conformity with a scientific advance
186 in
187 the method of controlling or eradicating a Dreissena mussel.
188 (6) (a) The division may not close or quarantine a water supply system if the operator
189 has prepared and implemented a plan to control or eradicate a Dreissena mussel in
190 accordance
191 with Subsection (5).
192 (b) (i) The division may require the operator to update a plan.
193 (ii) If the operator fails to update or revise a plan, the division may close or
194 quarantine
195 the water supply system in accordance with this section.
196 Section 8. Section **23-27-401** is enacted to read:
197 **Part 4. Administration**
198 **23-27-401. Rulemaking authority.**
199 In accordance with Title 63, Chapter 46a, Utah Administrative Rulemaking Act, the
200 board may make rules that:
201 (1) establish the procedures and requirements for decontaminating a conveyance or
202 equipment to prevent the introduction and infestation of a Dreissena mussel;

199 (2) establish the requirements necessary to provide proof that a conveyance or
200 equipment is decontaminated;
201 (3) establish the notification procedures required in Section 23-27-303;
202 (4) identify the geographic area, water body, facility, or water supply system that is
203 infested by Dreissena mussels;
204 (5) establish a procedure and protocol in cooperation with the Department of
205 Transportation for stopping, inspecting, detaining and decontaminating a conveyance
or
206 equipment at a port-of-entry in accordance with Section 23-27-301; and
207 (6) are necessary to administer and enforce the provisions of this chapter.
208 Section 9. Section **72-9-501** is amended to read:
209 **72-9-501. Construction, operation, and maintenance of ports-of-**
entry by the
210 **department -- Function of ports-of-entry -- Checking and citation**
powers of port-of-entry
211 **agents.**

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212 (1) (a) The department shall construct ports-of-entry for the purpose of checking
motor
213 carriers, drivers, vehicles, and vehicle loads for compliance with state and federal
laws
214 including laws relating to:
215 (i) driver qualifications;
216 (ii) Title 53, Chapter 3, Part 4, Uniform Commercial Driver License Act;
217 (iii) vehicle registration;
218 (iv) fuel tax payment;
219 (v) vehicle size, weight, and load;
220 (vi) security or insurance;
221 (vii) this chapter;
222 (viii) hazardous material as defined under 49 U.S.C. 5102;
223 (ix) livestock transportation; and
224 (x) safety.
225 (b) The ports-of-entry shall be located on state highways at sites determined by the
226 department.
227 (2) (a) The ports-of-entry shall be operated and maintained by the department.
228 (b) A port-of-entry agent or a peace officer may check, inspect, or test drivers,
vehicles,
229 and vehicle loads for compliance with state and federal laws specified in Subsection
(1).
230 (3) (a) A port-of-entry agent or a peace officer, in whose presence an offense
described
231 in this section is committed, may:
232 (i) issue and deliver a misdemeanor or infraction citation under Section 77-7-18;
233 (ii) request and administer chemical tests to determine blood alcohol concentration in
234 compliance with Section 41-6a-515;
235 (iii) place a driver out-of-service in accordance with Section 53-3-417; and
236 (iv) serve a driver with notice of the Driver License Division of the Department of
237 Public Safety's intention to disqualify the driver's privilege to drive a commercial
motor vehicle
238 in accordance with Section 53-3-418.
239 (b) This section does not grant actual arrest powers as defined in Section 77-7-1 to a

240 port-of-entry agent who is not a peace officer or special function officer designated under Title

241 53, Chapter 13, Peace Officer Classifications.

242 (4) (a) A port-of-entry agent, a peace officer, or the Division of Wildlife Resources
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243 may inspect, detain, or quarantine a conveyance or equipment in accordance with Sections

244 23-27-301 and 23-27-302.

245 (b) The department is not responsible for decontaminating a conveyance or equipment

246 detained or quarantined.

247 (c) The Division of Wildlife Resources may decontaminate, as defined in Section
248 23-27-102, a conveyance or equipment at the port-of-entry if authorized by the department.

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APPENDIX E2

R657. Natural Resources, Wildlife Resources.

R657-60. Aquatic Invasive Species Interdiction.

R657-60-1. Purpose and Authority.

(1) The purpose of this rule is to define procedures and regulations designed to prevent and control the spread of aquatic invasive species within the State of Utah.

(2) This rule is promulgated pursuant to authority granted to the Wildlife Board in Sections 23-27-401, 23-14-18, and 23-14-19.

R657-60-2. Definitions.

(1) Terms used in this rule are defined in Section 23-13-2 and 23-27-101.

(2) In addition:

(a) "Conveyance" means a terrestrial or aquatic vehicle, including a vessel, or a vehicle part that may carry or contain a Dreissena mussel.

(b) "Decontaminate" means to:

(i) Self-decontaminate equipment or a conveyance that has been in an infested water in the previous 30 days by:

(A) removing all plants, fish, mussels and mud from the equipment or conveyance;

(B) draining all water from the equipment or conveyance, including water held in ballast tanks, bilges, livewells, and motors; and

(C) drying the equipment or conveyance for no less than 7 days in June, July and August; 18 days in September, October, November, March, April and May; 30 days in December, January and February; or expose the equipment or conveyance to sub-freezing temperatures for 72 consecutive hours; or

(ii) Professionally decontaminate equipment or a conveyance that has been in an infested water in the previous 30 days by:

(A) Using a professional decontamination service approved by the division to apply scalding water (140 degrees Fahrenheit) to completely wash the equipment or conveyance and flush any areas where water is held, including ballast tanks, bilges, livewells, and motors.

(c) "Dreissena mussel" means a mussel of the genus Dreissena at any life stage, including a zebra mussel, a quagga mussel and a Conrad's false mussel.

(d) "Controlling entity" means the owner, operator, or manager of a water body, facility, or a water supply system.

(e) "Equipment" means an article, tool, implement, or device capable of carrying or containing water or Dreissena mussel.

(f) "Facility" means a structure that is located within or adjacent to a water body

(g) "Infested water" includes all the following:

(i) lower Colorado River between Lake Mead and the Gulf of California;

(ii) Lake Mead in Nevada and Arizona;

(iii) Lake Mohave in Nevada and Arizona;

- (iv) Lake Havasu in California and Arizona;
 - (v) Lake Pueblo in Colorado;
 - (vi) Lake Pleasant in Arizona;
 - (vii) San Justo Reservoir in California;
 - (viii) Southern California inland waters in Orange, Riverside, San Diego, Imperial, and San Bernardino counties;
 - (ix) coastal and inland waters east of the 100th Meridian in North America;
- and
- (x) other waters established by the Wildlife Board and published on the DWR website.
- (h) "Vessel" means every type of watercraft used or capable of being used as a means of transportation on water.
- (i) "Water body" means natural or impounded surface water, including a stream, river, spring, lake, reservoir, pond, wetland, tank, and fountain.
- (j) "Water supply system" means a system that treats, conveys, or distributes water for irrigation, industrial, wastewater treatment, or culinary use, including a pump, canal, ditch or, pipeline.
- (i) "Water supply system" does not include a water body.

R657-60-3. Possession of Dreissena Mussels.

(1) Except as provided in Subsections R657-60-3(2) and R657-60-5(2), a person may not possess, import, ship, or transport any Dreissena mussel.

(2) Dreissena mussels may be imported into and possessed within the state of Utah with prior written approval of the Director of the Division of Wildlife Resources or a designee.

R657-60-4. Reporting of invasive species required.

(1) A person who discovers a Dreissena mussel within this state or has reason to believe a Dreissena mussel may exist at a specific location shall immediately report the discovery to the division.

(2) The report shall include the following information:

- (a) location of the Dreissena mussels;
 - (b) date of discovery;
 - (c) identification of any conveyance or equipment in which mussels may be held or attached; and
 - (d) identification of the reporting party with their contact information.
- (3) The report shall be made in person or in writing:
- (a) at any division regional or headquarters office or;
 - (b) to the division's toll free hotline at 1-800-662-3337; or
 - (c) on the division's website at www.wildlife.utah.gov/law/hsp/pf.php.

R657-60-5. Transportation of equipment and conveyances that have been in infested waters.

(1) The owner, operator, or possessor of any equipment or conveyance that has been in an infested water shall:

(a) immediately drain all water from the equipment or conveyance at the take out site, including water held in ballast tanks, bilges, livewells, motors, and other areas of containment; and

(b) immediately inspect the interior and exterior of the equipment or conveyance at the take out site for the presence of Dreissena mussels.

(2) If all water in the equipment or conveyance is drained and the inspection undertaken pursuant to Subsection (1)(b) reveals the equipment and conveyance are free from mussels or shelled organisms, fish, plants and mud, the equipment and conveyance may be transported in or through the state directly from the take out site to the location where it will be:

(a) professionally decontaminated; or

(b) stored and self-decontaminated.

(3) If all the water in the equipment or conveyance is not drained or the inspection undertaken pursuant to Subsection (1)(b) reveals the equipment or conveyance has attached mussels or shelled organisms, fish, plants, or mud, the equipment and conveyance shall not be moved from the take out site until the division is contacted and written or electronic authorization received to move the equipment or conveyance to a designated location for professional decontamination.

(4) A person shall not place any equipment or conveyance that has been in an infested water in the previous 30 days into any other water body or water supply system in the state without first decontaminating the equipment or conveyance.

R657-60-6. Certification of Decontamination

(1) The owner, operator or possessor of a vessel desiring to launch on a water body in Utah must:

(a) verify the vessel and any launching device have not been in an infested water in the previous 30 days; or

(b) certify the vessel and launching device have been decontaminated.

(2) Certification of decontamination is satisfied by:

(a) previously completing self-decontamination since the vessel and launching device were last in an infested water and completely filling out and dating a decontamination certification form which can be obtained from the division; or

(b) providing a signed and dated certificate by a division approved professional decontamination service verifying the vessel and launching device were professionally decontaminated since the vessel and launching device were last in an infested water.

(3) Both the decontamination certification form and the professional decontamination certificate, where applicable, must be signed and placed in open view in the window of the launching vehicle prior to launching or placing the vessel in a body of water.

(4) It is unlawful under Section 76-8-504 to knowingly falsify a decontamination certification form.

R657-60-7. Wildlife Board designations of infested waters.

(1) The Wildlife Board may designate a geographic area, water body, facility, or water supply system as infested with Dreissena mussels pursuant to Section 23-27-102 and 23-27-401 without taking the proposal to or receiving recommendations from the regional advisory councils.

R657-60-8. Closure Order for a Water Body, Facility, or Water Supply System.

(1)(a) If the division detects or suspects a Dreissena mussel is present in a water body, facility, or water supply system, the division director or designee may, with the concurrence of the executive director, issue an order closing the water body, facility, or water supply system to the introduction or removal of conveyances or equipment.

(b) The director shall consult with the controlling entity of the water body, facility, or water supply system when determining the scope, duration, level and type of closure that will be imposed in order to avoid or minimize disruption of economic and recreational activities.

(2)(a) A closure order issued pursuant to Subsection (1) shall be in writing and identify the:

- (i) water body, facility, or water supply system subject to the closure order;
- (ii) nature and scope of the closure or restrictions;
- (iii) reasons for the closure or restrictions;
- (iv) conditions upon which the order may be terminated or modified; and
- (v) sources for receiving updated information on the status of infestation

and closure order.

(b) The closure order shall be mailed, electronically transmitted, or hand delivered to:

- (i) the controlling entity of the water body, facility, or water supply system; and
- (ii) any governmental agency or private entity known to have economic, political, or recreational interests significantly impacted by the closure order; and
- (iii) any person or entity requesting a copy of the order.

(c) The closure order or its substance shall further be:

- (i) posted on the division's web page; and
- (ii) published in a newspaper of general circulation in the state of Utah or the affected area.

(3) If a closure order lasts longer than seven days, the division shall provide the controlling entity and post on its web page a written update every 10 days on its efforts to address the Dreissena mussel infestation.

(a) The 10 day update notice cycle will continue for the duration of the closure order.

(4)(a) Notwithstanding the closure authority in Subsection (1), the division may not unilaterally close or restrict a water supply system infested with Dreissena mussels where the controlling entity has prepared and implemented a control plan in cooperation with the division that effectively eradicates or controls the spread of Dreissena mussels from the water supply system.

- (b) The control plan shall comply with the requirements in R657-60-9.

R657-60-9. Control plan required

(1) The controlling entity of a water body, facility, or water supply system may develop and implement a control plan in cooperation with the division prior to infestation designed to:

- (a) avoid the infestation of Dreissena mussels; and
- (b) control or eradicate an infestation of Dreissena mussels that might occur in the future.

(2) A pre-infestation control plan developed consistent with the requirements in Subsection (3) and approved by the division will eliminate or minimize the duration and impact of a closure order issued pursuant to Section 23-27-303 and R657-60-8.

(3) Upon detection of a Dreissena mussel and issuance of a division closure order involving a water body, facility, or water supply system without an approved control plan, the controlling entity shall cooperate with the division in developing and implementing a control plan to address the:

- (a) scope and extent of the infestation;
- (b) actions proposed to control the pathways of spread of the infestation;
- (c) actions proposed to control or eradicate the infestation;
- (d) methods to decontaminate the water body, facility, or water supply system, if possible;
- (e) actions required to systematically monitor the level and extent of the infestation; and
- (f) requirements and methods to update and revise the plan with scientific advances.

R657-60-10. Procedure for Establishing a Memorandum of Understanding with the Utah Department of Transportation.

(1) The division director or designee shall negotiate an agreement with the Utah Department of Transportation for use of ports of entry for detection and interdiction of Dreissena Mussels illegally transported into and within the state. Both the Division of Wildlife Resources and the Department of Transportation must agree upon all aspects of Dreissena Mussel interdiction at ports of entry.

(2) The Memorandum shall include the following:

- (a) methods and protocols for reimbursing the department for costs associated with Dreissena Mussel interdiction;
- (b) identification of ports of entry suitable for interdiction operations;
- (c) identification of locations at a specific port of entry suitable for interdiction operations;
- (d) methods and protocols for disposing of wastewater associated with decontamination of equipment and conveyances;
- (e) dates and time periods suitable for interdiction efforts at specific ports of entry;

(f) signage notifying motorists of the vehicles that must stop at the port of entry for inspection;

(g) priorities of use during congested periods between the department's port responsibilities and the division's interdiction activities;

(h) methods for determining the length, location and dates of interdiction;

(i) training responsibilities for personnel involved in interdiction activities;
and

(j) methods for division regional personnel to establish interdiction efforts at ports within each region.

R657-60-11. Penalty for Violation.

A violation of any provision of this rule is punishable as provided in Section 23-13-11.

Appendix F

Asian Tapeworm (*Bothriocephalus acheilognathi*) Host List

Hosts^{1,1a,2,3,4}

Potential hosts are any fish that eat the intermediate copepod hosts (*Cyclops* and *Diaptomus*). Primary hosts are cyprinoids (carps, minnows, suckers, etc.). It also infects some centrarchids (sunfish family), percids (perch, walleye, sauger, pike), poecilids (live bearers), siluroids (catfishes). The Asian tapeworm is non-host specific. It only requires two hosts, instead of the usual three hosts for cestodes.⁴ It has not yet been reported in salmonids.

North American hosts include (1) cyprinoids such as the grass carp (*Ctenopharygodon idella*), common carp and koi (*Cyprinus carpio*), roundtail chub (*Gila robusta*), bonytail chub, virgin spinedace (*Lepidomeda mollispinis*), peamouth (*Mylocheilus*), golden shiner (*Notemigonus crysoleucas*), emerald shiner (*Notropis atherinoides*), red shiner (*Notemigonus lutrensis*), spotfin shiner (*Notropis spilopterus*), fathead minnow (*Pimephales promelas*), woundfin minnow (*Plagopterus argentissimus*), Colorado squawfish (*Ptychocheilus lucius*), speckled dace (*Rhinichthys osculus*); (2) green sunfish (*Lepomis cyanellus*), a centrarchid; and (3) the poeciliid mosquito fish (*Gambusia affinis*).^{1a}

Utah hosts include species infected in the Virgin River such as roundtail chub, woundfin minnow, speckled dace, red shiner, and virgin spinedace. In Utah Valley, infected fish are grass carp and fathead minnow. The source of the worm in the Virgin River / Lake Meade area was from infected bait minnows from the Midwest used by fishermen.^{1,3}

European hosts are perch (*Stizostedion*), catfish (*Silurus glanus*), crucian carp (*Carassius carassius*), guppies (*Lebistes*), and mosquito fish.^{1a}

The worm has never been found in bass (anywhere). It has not been found in percids (yellow perch, walleye, sauger, and pike) in North America. In the U.S., goldfish (*Carassius auratus*) appear to be refractory to infection.^{1a}

References

1. Personal communication between A. K. Hauck and Dick Heckmann, Professor of Zoology, BYU, in October 1993, June 1994, April and June 1996.
- 1a. Personal communication between A. K. Hauck and Drew Mitchell, US National Biological Survey, Stuttgart, AR, in October 1993, August 1994, June 1995, and April 1996.

2. Thoesen, John C., Editor. 1994. Suggested procedures for the detection and identification of certain finfish and shellfish pathogens. 4th ed., Version 1, Fish Health Section, American Fisheries Society.
3. Heckmann, R. A., Greger, P. D. and J. E. Deacon. The Asian Fish Tapeworm Infecting Endangered Fish Species from the Virgin River, Utah, Nevada, and Arizona. FHS/AFS Newsletter, 1986. 14(1):5
4. Heckmann, R. A. Praziquantel for Treatment of Grass Carp Infected with *Bothriocephalus acheilognathi*. FHS/AFS Newsletter, 1995. 23(3):11-13.



Appendix H

UDWR's Aquatic Invasive Species Team

24/7 Request Decontamination or Report Violations
1(800) 662-DEER (1-800-662-3337)

SOUTHERN REGION

- AIS BIOLOGIST: CRYSTAL STOCK (decontamination & questions)
 - **Cell** (435) 691-2427
 - **Office** (435) 865-6100
- LAW ENFORCEMENT: Lt. SCOTT DALEBOUT (violations)
 - **Cell** (435) 691-3588

SOUTHEASTERN REGION

- AIS BIOLOGIST: DAN KELLER (decontamination & questions)
 - **Cell** (435) 630-3132
 - **Office** (435) 613-3720
- LAW ENFORCEMENT: Lt. CARL GRAMALICH (violations)
 - **Cell** (435)-820-6011

CENTRAL REGION

- AIS BIOLOGIST: EVAN FREEMAN (decontamination & questions)
 - **Cell** (435) 503-4066
 - **Office** (801)-491-5678
- LAW ENFORCEMENT: Lt. Scott White (violations)
 - **Cell** (801) 243 3061

NORTHERN REGION

- AIS BIOLOGIST: JENNY POLLOCZEK (decontamination & questions)
 - **Cell** (801) 648-6315
 - **Office** (801) 476-2740
- LAW ENFORCEMENT: Lt. Scott Davis (violations)
 - **Cell** 801 725-8988

NORTHEASTERN REGION

- AIS BIOLOGIST: NATALIE MUTH (decontamination & questions)
 - **Cell** (435) 790-8938
 - **Office** (435) 781-9453
- LAW ENFORCEMENT: Lt. TORRY CHRISTOPHERSON (violations)
 - **Cell** (435) 790-2291

**NOTE: If any lieutenant is unavailable,
contact Captain John Pratt 801 450-3311**

**General Questions about UDWR's ANS program
Larry Dalton, AIS Coordinator, Salt Lake City, UT
801 652-2465**

Zebra & Quagga Mussel interdiction Protocol

